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The So-Called Panic.

It is unfortunate that a number of young men engaged on our daily papers have not learned to be a little more careful in their use of the English language. A somewhat careful observation of the news sheets of the country during the last fortnight shows that, in an attempt to be sufficiently sensational to make papers sell, conditions in the manufacturing and commercial world have been called by pretty hard names they by no means deserved. If the American people did not have an exceptional amount of common sense and were not thoroughly convinced that because a thing was stated in the newspaper it was not necessarily correct, we might have had a real panic on our hands. Nothing of the sort has happened because about all the people who have been hurt are those who, for one reason or another, have had their affairs so extended as to be unwieldly. A shipmaster who carries all sail too long has a good deal of trouble when the wind freshens with unexpected rapidity. A business man who was doing more than his capital warranted in flush times is likely to have trouble when such an exceptional period subsides to the normal. We have been having flush times for a number of years. They have been continuing for so long, indeed, that we have become accustomed to them, and have forgotten just exactly what is necessary when real normal conditions prevail. When mills are filled with orders so far ahead that new business is not wanted, as was the condition a year ago, affairs may truly be called booming. It is wholly unreasonable to expect them to continue to boom. We must expect to work harder than we have the last two or three years in order to accomplish as much, but it is difficult to see what reason there is for anticipating a panic. Certainly there is very little in view at the present time to warrant any such apprehension, and a misapprehension of some recent events, magnified in the newspapers, is the only thing that needs explanation just now.

In the first place there have been reports concerning the shutting down of some industrial plants. It is well to look at these things in a rational manner. A good many establishments have been running under the highest pressure for some years. Their machinery has been used by day and night forces until it is in great need of repair. More than a year ago The Engineering Record was informed by the managers of certain works that it would be necessary to shut down for repairs or their plants would drop to pieces, yet these same plants have been kept running all through the summer. Some of them are among the mills which have closed recently. They have not stopped solely because of business conditions, but because it is high time for repairs and renewals. Probably many more establishments would report the same condition of affairs. This is the beginning of the season when such work is done. Because production has been conducted under such extreme pressure during the last two years that these annual periods of recuperation have not been possible is no precedent for their continual omission. It is noticeable, moreover, that in a good many cases where these shut-downs have occurred that the American workmen are kept busy, at least in a considerable measure, and the men who have been turned off are the Italians and other Europeans who are taking advantage of this closing of the works to visit their native land. That is not a mere conjecture can be ascertained by inquiry at any shipping office.

There are a few manufacturers who are apprehensive and talking of closing down their plants entirely. It might be well for them to consider that any unnecessary retrenchment is likely, in view of the recent prevalence of unwarranted rumors of a panic, to be a cause of further hardening of conditions, rather than a remedy. "Every business enterprise which is making any unnecessary retrenchment," according to a recent address by Mr. Henry L. Doherty, "is adding just that much to the situation which is bringing about a threatened industrial depression." Mr. Doherty's connections are so important and so widely spread throughout the country that his further assertion that we are suffering merely from a lack of confidence deserves careful consideration. "United efforts on the part of the men of influence of this country could quickly restore the confidence which is lacking," in his opinion, "but unfortunately they have as yet no means of taking united action, no attempt has heretofore been made to do so, and of the numerous half-baked suggestions which have been offered as a cure, few, if any, would stand the analysis of proper logic."

It may be confidently asserted that the thing for business men, particularly manufacturers, to do at the present time is to form local associations for steadying the weak-kneed people in their vicinity. One good, strong local association of manufacturers in any city can accomplish a great deal of good. If the trouble which is now passing away had no other effect than to form these local organizations it would have accomplished a great deal. Manufacturers must stand together just as laboring men stand together. During the last two weeks there has been a pitiful exhibition of cold feet on the part of the bankers in some cities, particularly west of the Allegheny Mountains. Manufacturers should unite to prevent any such fright affecting them. It is entirely practicable for them to do so by simple means. A great deal of cash can be brought to light, when bankers are too scared to advance money on good security, by making a trust fund of these securities and issuing notes of small amounts against it, or something of this sort. There are plenty of men having small sums to invest who will come forward at such times, provided they are assured that responsible people are connected with this method of raising money. If an association of local manufacturers undertakes to raise funds for some of its members in this way, it is safe to say that a good deal of hidden money will be brought to light and the currency conditions will be so much improved.

It is the currency conditions that are mainly responsible for the present trouble. Some of these conditions can be changed only by Congress, and fortunately Congress seems to be willing to talk about the matter. Moreover, it will act just as soon as the influential men of the country call loudly enough for a reform. Congress has never failed to do this in the past and there is no reason to expect it will refuse to do so now. But all of the trouble has not been due to our rigid currency laws. Some of it has been caused by the hasty action of people who felt that a panic was coming and withdrew their money from the banks, hiding it away where it was of no use to them or to anybody else. This not only deprived them of interest and jeopardized the safety of their funds, but it also had a tendency to create a condition that might have become very serious. These people, most of them of small means, may be pardoned for their timidity. This cannot be said, however, of those banks which have shown the white feather before firing began. There is nothing so pitiful as a coward who does not even wait to see if the fight is going against him. The cowardice of some bankers during the last month is hardly to be believed. Instead of doing all they could to allay the sudden wave of unwarranted apprehension which swept the country, they did all they could to increase the uneasy feeling. They have hoarded away enormous sums of currency which should have been paid out to their customers in the usual banking ways, without regard to the fact that bank reserves are kept for the purpose of relieving sudden unexpected calls for large sums and not as ornaments for the annual balance sheets. Every bank owes an obligation to the community in which it is situated. Any bank holding more currency than its legal reserve is doing great harm to every business interest and merits no consideration whatever at the hands of merchants, manufacturers or labor. It is high time for manufacturing and mercantile interests to do no business with these lily-livered institutions which are no help to the community. Business men will do well to remove their accounts from such banks, to think twice before making any unnecessary reductions in their force of employees, and to form local associations to check still further the senseless scare.

Costs of Engineering Work.

The Commissioners of Accounts of the city of New York have been conducting during the past ten days an investigation of the conditions under which Contract No. 3 of the Board of Water Supply, covering the construction of the main dam, dykes and other works of the great Ashokan Reservoir was awarded some months ago. As was set forth in this journal there were five bids for this work. The law under which the Board of Water Supply is acting does not require the tender of the lowest responsible bidder to be accepted, but lays upon the Board the most serious responsibility of so awarding the contract as will, in its judgment, best serve the interests of the city. After carefully canvassing all the bids the contract was awarded to MacArthur Brothers Co. and Winston & Co., who were next above the John Peirce Company, the lowest bidder, the contract price being above the bid of the latter.

This investigation, like most other investigations of technical matters by city commissioners whose members know little or nothing about the things to be investigated, has already developed into a voluminous irrelevant examination, of the members of the Board and its engineering organization, but it has occasionally touched on things more germain to the real substance of the inquiry. After the usual efforts of lawyers under such conditions to discredit the the evidence of eminent engineers of twenty to forty years of active professional work, it has seemed to be one of the principal objects of the Commissioners of Accounts and their technical advisors to show that the unit costs of such earth and rock excavation and rolled embankments of selected material, are as susceptible of accurate estimation by the aid of information disclosed by wash and core borings and other preliminary examinations as the unit prices of standard grades of structural steel work. The physical environment of the structural shop is with rare exceptions steady and unchanging. The labor conditions are as constant as it is possible to make them, and the various classes of structural work produced may be fairly well determined under the specifications and contract plans. Such circumstances enable the cost of work to be predetermined, not with mathematical exactness but with reasonable accuracy for business purposes; hence, it may be argued by the layman, the estimated cost of any engineering work should be determined with equal accuracy under similar specification and contract plans, especially if the location of the work may be examined by prospective bidders and if the requisite borings have been made and other practicable means have been taken to secure the requisite information as to physical or other conditions affecting the work to be done.

All this appears plausible enough but any engineer of extended experience knows well how fundamentally misleading such plausibility may be, and usually is. It has been fully and forcefully brought out by the chief engineer and by the consulting engineers of the Board of Water Supply that reasoning from practically fixed conditions, such as those of the structural shop, to the erratic and indeterminable conditions of most of such great field constructions as those of the Board of Water Supply is both misleading and dangerous. If, for instance, the earth and rock excavation required for the Ashokan dam and the dykes, gate houses and other appurtenances of the reservoir in question, amounting to perhaps 2,000,000 cu. yd., were to be made under conditions practically equivalent to those which governed similar parts of the new Croton dam contract, it is reasonable to suppose that a fairly close estimate of cost for the former could be made, allowing for difference in the labor conditions at the two sites. A little familiarity only with the two pieces of work, however, is enough to show that there is no parity between them. Remarkably full examinations have been made at the site of the Ashokan work and enough has been disclosed there to show that the materials to be taken out are radically different from those at the Croton dam nor is there reason to suppose that the general physical conditions have any material similarity. The treatment of the rock foundation bed will have to be very different, the depths to which trenches for core walls will have to be carried is not certainly known, although probabilities have to be estimated, and the amount of water to be encountered and taken care of is exceedingly uncertain. In fact the general character of the conditions found at Ashokan, as at every other great work of the same class, is really unknown until the actual progress of the work discloses it. It is only the tyro in engineering, or the bookman, who would attempt to predict with accuracy the elements of cost of any of the great classes of field construction.

Both the engineer and the contractor must make estimates of cost under such circumstances as best they can. It is usually these great uncertainties of cost which make the corresponding divergencies in such estimates so often found among even experenced engineers and contractors, and exhibited frequently in the wide range of prices in competitive bidding. It is in this particular field of engineering that the well developed judgment plays the crucial part. The estimated unit costs in such cases are more largely matters of judgment than of carefully systematized analyses of other work of the same class. Most careful consideration must of necessity be given to prior contracts of the same kind, but comparisons must be made by the aid of and frequently radically tempered by judgment developed by experience; any direct referance without the qualification of such judgment is practically certain to be grossly misleading, and it has been frequently seriously misleading to contractors as was shown in the Jerome Avenue reservoir contract in New York. No attractive printed tabulations of preceding costs of other contracts can safely form the basis of sensible conclusions of the costs of these great field constructions; such sources of data are deceptive and dangerous unless cautiously handled. The law has wisely made the duty of awarding the Ashokan and other contracts of the Board of Water Supply, a matter of the best judgment of the Board guided by its experienced engineering organization, acting for the best interests of the city, and it is not good public policy to permit captious criticism of politics or the unscrupulous members of the daily press to frustrate the intent of the statute when it is efficiently followed in spirit and letter.

The Steel Rail Controversy.

The unsatisfactory results in service of the heavy-section steel rails rolled during recent years have brought forth from both the manufacturer and the consumer numerous suggestions of the causes of these results and of methods to prevent them. The representatives of the steel mills are united in the opinion that the number of actual rail failures has been greatly exaggerated. They consider such failures as have occurred to be due primarily to the fact that the standard sections adopted some years ago are not suited to the heavy rails required to carry the greatly increased train loadings, the tremendous volume of traffic and the higher speeds which have developed since then. They are of the further belief that improvements in the construction of track and equipment have not kept pace with the requirements presented by these changed conditions. The railway interests have generally conceded likewise that the present standard rail sections should be modified, and in numerous meetings of the various technical societies made up of, or including, railway engineers and operative officers as members, improved methods of track and equipment construction have been much discussed. These interests, however, attribute the unsatisfactory rails that have been produced to several more causes considered equally vital. Chief among them are, first, the failure to discard a sufficient amount of steel from the top of the ingot from which the rails are rolled; second, improper chemical composition of the steel; and, third, the physical weakness of the rails due to existing methods of manufacture.

The steel makers and the railway interests are not only agreed that the present standard section should be revised, but they are also in accord regarding the general plan to be followed in making the changes. For the heavy rails now regularly used on the main-line tracks of most railroads, the flange and web are held to be too light in proportion to the head. A proposed change, known as the Harriman sections, as well as another series, known as the Pennsylvania sections, both of which add considerable weight to the flanges and webs in proportion to the heads, and also have a narrower flange than the present standards, have been recommended by the rail committee of the American Railway Association. Since the rail manufacturers have made no protest against these findings of this committee, it is reasonable to assume they are satisfied with the action that has been taken, and, in fact, the decision of the committee followed consultation with the manufacturers.

The proposed changes have been suggested chiefly to overcome the difficulties of manufacture presented in rolling rails to the present standard sections. The latter have so much metal in the head in proportion to the web and flange that the head cools much more slowly than the balance of the rail, resulting in internal structural strains. The large proportion of metal in the head also requires the work of rolling to be executed while the steel is too hot to yield the most satisfactory results in structure. The improper balance of proportions in the parts of the rail affect particularly the high-carbon steel used in a large percentage of the rails now produced. The lighter head and the narrower, thicker flange of the proposed sections are expected to alleviate greatly this paramount difficulty of manufacture, and thus result in rails which will be mechanically stronger and better. Grounds for objections to a section with a narrower flange than that of the present standard might appear to be justified, due to a reduction of bearing area on the cross ties, if it were not for the fact that tie plates are now almost universally used by railroads having heavy rails, particularly where soft wood ties are employed.

While the manufacturers and consumers are more or less generally agreed concerning the changes which should be made in the standard sections for rails, they are widely at variance in regard to the percentage of steel that must be sheared from the top of the ingot to eliminate defects from piping. A committee of the American Railway Engineering and Maintenance of Way Association and one from the American Society of Civil Engineers have both recommended that a minimum of 25 per cent. should be discarded from the top of each ingot. The committee of the American Railway Association has discussed the rejection of a minimum of 20 per cent. of the ingot. The rail makers regard any such discard as an injustice, and as unnecessary. They also state that a rejection of 25 per cent. of each ingot will reduce the output of the mills by that amount, and will increase the cost of manufacture accordingly. As a matter of fact, a very carefully compiled record made

recently shows that in about a dozen of the largest rail mills in this country an average of from about 5 per cent. to about 14 per cent. of the ingot is discarded under the present methods. Freedom from piping danger may not be in exact proportion to the proposed amount of metal to be discarded, but it is evident that the proposed increase will not alter conditions so greatly as might first appear.

The chief controversy between the steel makers and the railway interests over the chemical composition of the steel now used is principally in regard to the phosphorous content. The consumers desire to limit the phosphorous to 0.085 per cent. The manufacturers contend that with the available ores this is an impracticable limit, and suggest 0.1 per cent. This contention may be well taken, but one steel mill on this continent is producing in the neighborhood of 150,000 tons of steel rails per year, which contain as a maximum 0.085 per cent. of phosphorous. These rails are made from ore purchased in the open market in this country, and have given and are giving satisfactory results in service.

The details of the existing methods of manufacture which produce physical weakness in rails are not easily defined. The reduction in the number of passes or times an ingot is put through the rolls to produce a rail doubtless has some bearing on the unsatisfactory results. The structural strains incident to the more rapid forcing of the steel into the rail section may account also for some of the numerous mysterious breaks which have occurred in apparently sound rails. On the other hand, the proportions of the present sections are probably somewhat responsible for the poor physical character. It is apparent, moreover, that sections with smaller heads would have the structure of the latter of more nearly the same character as the balance of the rail, due to the additional work which the heads would receive. The methods of paying the mill operatives according to the total output and other similar conditions also have a tendency to produce hasty work, which naturally may not be done with sufficient thoroughness. In other words, in the effort to increase production there is danger that the quality of the product has not been kept sufficiently prominent.

Whatever the merits of the contentions presented by the two interests chiefly concerned may be, it is certain that heavy rails which will give uniformly satisfactory service must be produced. If such rails cannot be manufactured at the existing prices, the steel mills should present the case clearly to the railway interests with the provision that they can and will meet the proper requirements at an increased cost, to be demonstrated. Action of this kind made in a reasonable manner would relieve the makers of responsibility. It would also forestall any grounds for government investigations and perhaps interference, which appear to be probable, and would likewise remove a strong argument for the reduction or removal of the tariff on steel rails, as has been widely advocated of late from various responsible quarters.

Repair Shop Expansion.

A modern industrial plant designed for the economical manufacture of standard products is almost always built with the idea of providing for future growth without undue expense. Remodeling of factory buildings is becoming less frequent, as comprehensive plans for expansion are originally laid down, and few owners begrudge the time taken by their architects and engineers to round out a logical scheme of development on paper before the earth is turned at the site of the new establishment. The power plant is located in or near the center of future distribution, and space is usually provided for a large increase in generating capacity without the erection of a new building; side tracks, passageways, spurs into buildings and the main structures themselves are put down in such a way that liberal growth can take place without hampering the usefulness of existing facilities. Even the foundations are often built for future tool locations, and the heating and ventilating problem in the larger plant is ordinarily met by an extension of the methods of solution found satisfactory in the first installation.

The conditions in a shop devoted to repair practice or other non-routine work are decidedly different. To foresee the line of development probable in such an establishment is far more difficult than to plan for the growth of a standard-product factory. In a repair shop attached to a particular industry alone the conditions are easier, although the development in every line of mechanical endeavor is so progressive in these days that expansion plans must be made on a broad basis if later conditions are not to find cramped and inefficient facilities at hand. Thus, in the electric railway field a new repair shop can be built to handle the present type of rolling stock with efficiency and space allowed for growth along present lines; but a wise design will consider not alone the probability of being obliged to maintain here an increased number of cars like the present units, but also the fair certainty of having to deal in a very few years with motors of perhaps 50 per cent. more power and cars of from 25 to 50 per cent. more weight than those of to-day, on any line or system where the competition to secure faster service or greater comfort is beginning to be felt. The probable growth of the industrial unit cannot be overlooked in the planning of expansion.

In the general shop for machines and metal repairs and for the development of varied iron and steel structures on special orders, the exact trend of future business can seldom be definitely postulated. Several points can be provided for, however, in the endeavor to meet the changed conditions anticipated. Ample power supply, absence of obstructive movements of stock against the normal course of internal handling, provision for plenty of natural light and continuous expansion of the heating and ventilating systems are essential to the avoidance of congestion. By planning the concentration of the heaviest class of machine tool work at one section of the building, as in the standard centre aisle swept by overhead crane facilities, the most indefinite future repair jobs on a large scale need cause few anxieties. Extension of the centre aisle for heavy work and expansion of the side bays for the lighter jobs will meet any probable conditions. When the design will not permit of symmetrical expansion, as in city shops, located on odd-shaped lots, the problem can sometimes be solved by reconstructing a portion of the bays devoted to the lighter work and turning these sections over to the heavy tools, which naturally are grouped together on the ground floor. It is a simple matter to relocate benches and speed lathes, small shapers, grinders and the less massive equipment of the ordinary machine shop, and sometimes a special mezzanine floor section can be built for this transfer. Interference of one job with another must be avoided like a pestilence, if economy of shop operation is to be retained in the growth of the works.

It is in changes of this character that the usefulness of the electric drive specially appears, for the independence of line shaft locations common to every electric system enables tools to be placed almost anywhere that the shop structure can support them. Even the group driving of machines by motors offers only less latitude in the re-location of equipment. Modern methods of electric lighting are equal to almost any demand from the shop foreman in the way of making the desert places to blossom with productivity, and the flexibility and economy of electric power never can do otherwise than facilitate expansion.

Notes and Comment.

GRADE CROSSING ELIMINATION is work of such growing importance near most of our large cities that the article on an undertaking of this sort on the Boston & Albany Railroad, printed on another page, deserves special notice. There was nothing particularly novel about this work, nor was it so difficult as the grade crossing elimination carried out by the Lackawanna engineers in Newark. It is for this reason that prominence has been given to the description, for it will doubtless be helpful to a good many engineers in the future, who have to carry out similar improvements. The problems in any such case are two-fold, to handle the traffic and to transport materials. Where the right of way is limited in width, the successive steps in the construction must generally be planned so as to avoid interference with traffic so far as practicable, and this may make it necessary to put down retaining walls in very narrow trenches. Cableways are employed to advantage in such work, but it would seem as though they might be supplemented with good results by the narrow-gauge railways that are coming into more general use by our contractors and have been extensively employed on all kinds of foundation work by European contractors for many years. Where the speedy completion of the change in grade is desirable, which is generally the case, these light railways present features that deserve careful consideration.

GREATER PITTSBURG, a city of 38 square miles in area and a population of 550,000 is assured by the decision of the United States Supreme Court that the consolidation of Pittsburg and Allegheny was not contrary to the Constitution or to any federal laws. The decision defines in explicit terms the rights of a state over a city, as shown in the following extract: "The state at its pleasure may modify or withdraw all such powers, may take without compensation such property, hold it itself, or vest it in other agencies, expand or contract the territorial area, unite the whole or a part of it with another municipality, repeal the charter and destroy the corporation. All this may be done, conditionally or unconditionally, with or without the consent of the citizens, or even against their protest. In all these respects the state is supreme, and its legislative body, conforming its action to the state constitution, may do as it will, unrestrained by any provision of the Constitution of the United States. Although the inhabitants and property owners may by such changes suffer inconvenience, and their property may be lessened in value by the burden of increased taxation, or for any other reason, they have no right, by contract or otherwise, in the unaltered or continued existence of the corporation or its powers, and there is nothing in the federal Constitution which protects them from these injurious consequences. The power is in the state, and those who legislate for the state are alone responsible for any unjust or oppressive exercise of it." Particular attention is called to this opinion of the court of final jurisdiction of the nation, because of its significance in connection with many important engineering affairs. For example, the water, sewerage and park work about Boston, the water-works at New York and the drainage works at Chicago are not strictly municipal undertakings in some respects, although directly for the benefit of the cities concerned. There is a manifest tendency toward state commissions for larger public works.

GRADE CROSSING ABOLITION AT NEWTON HIGHLANDS AND NEWTON CENTRE, MASS.

By WALTER C. WHITNEY, ASSISTANT ENGINEER, BOSTON & ALBANY R. R.

The Boston & Albany Railroad Co., is just finishing the work of the abolition of grade crossings on that part of its line known as the Newton Highlands branch. This is a double-track line which leaves the main line at Brookline Junction about 1½ miles from the South Terminal Station and running out through Brookline, and Newton joins the main line again at Riverside, about 10 miles further out. The work to be described lies in that part of the city of Newton known as Newton Highlands and Newton Centre. New grades of the railroad and streets were specified in the decision of the commissioners which passed upon the general project, and were ordered by the Superior Court. The work being on a branch line on which the traffic is wholly suburban passenger, with only one freight train a day, heavier grades were permissible for the tracks than would otherwise have been the case. Owing to the location of Crystal Lake close to the tracks it was deemed advisable to depress the tracks very little at that place. This fact made it possible to divide the work into two sections. The retaining walls and abutments of the Newton Highlands or westerly section were built in 1905. In 1906 the steel work of the bridges was erected at Newton Highlands and the retaining walls and abutments were built at Newton Centre. This year the steel work is being erected at Newton Centre.

The general layout and scheme of the work was as follows: Starting at Sta. 189 of the location of the railroad, the tracks were elevated at the rate of 0.316 per cent. or 16.68 ft. per mile to the first street at Sta. 201, where the tracks were elevated a total of 6.30 ft. and the street depressed 9.70 ft. The new rail grade from Sta. 201 descended at the rate of 1.06 per cent. or 56.0 ft. per mile until the fill ran out at the old rail grade at Sta. 208. The depression of the tracks began at Sta. 208 and the rate of 56 ft. per mile was continued to Langley Road at Sta. 215, where the street was raised 8.23 ft. and the track depressed 9.60 ft. From Langley Road the tracks run level to Institution Ave. at Sta. 222, where the railroad cut was 9.00 ft. Institution Ave. crossed the railroad by means of a wooden bridge and the elevation of the floor of the new bringle is about 1 ft. lower than the old. From Sta. 222 to Sta. 236, the new grade ascends at the rate of 0.336 per cent. or 17.74 ft. per mile. At Sta. 226 Cypress St. originally crossed the tracks by a wooden bridge, but was so elevated that in the change the new elevation of the street where it crosses the tracks is over 6 feet lower than the old. The railroad was depressed 7.30 ft. Glen Ave. and Institution Ave. are both 40-ft. streets, Langley Road 60 ft. and Cypress St. 50 ft. At Sta. 236 Centre St. crosses the tracks on a skew of 20 deg. 6 min. The street was originally 50 ft. wide but was widened 6 ft. in connection with the work. Centre St. was raised 13.47 ft. and the tracks depressed 5.33 ft. These five streets comprise the Newton Centre section. The work of making the fill at Glen Ave. and the construction of the abutments at that place were done in 1905, the remainder of the work in 1906 and 1907.

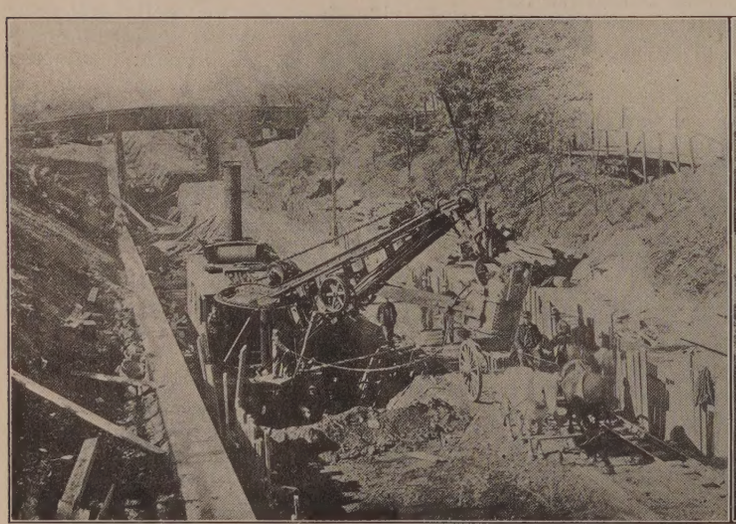
From Sta. 236 to Sta. 250 the tracks ascend at the rate of 0.41 per cent or 21.86 ft. per mile. At this latter station the depression of the tracks was only 5 in. and this point was made the dividing point in the steam shovel work between the two years' work. Rogers St. originally crossing the railroad at Sta. 247 was discontinued, and a new location given it at Sta. 251, where both abutments of the bridge are built on the face of a ledge. Rogers St. as relocated is 40 ft. wide. From Sta. 250 the tracks again descend, this time at a rate of 0.809 per cent. or 42.71 ft. per mile to Boylston St. at Sta. 277, passing under Hyde St. 40 ft. wide at Sta. 258 and Walnut St. 70 ft. wide at Sta. 266. Walnut St. is the main street of Newton Highlands, and the principal square is only about 100 ft. away from the railroad. At Hyde St. the tracks were depressed 6.25 ft. and the street raised 11.58 ft. At Walnut St. the depression was 11.80 ft., a part of Newton's boulevard system, is 90 ft. wide. The recently built Boston & Worcester Electric R. R. runs its cars over this bridge. At the time the line was built they were refused a crossing at grade with the railroad and passed over it by means of a wooden trestle. Piles were driven for the four bents nearest to the railroad, two on each side of the tracks, and these bents were so spaced that the concrete abutments could be built and the excavation for the railroad made without disturbing the electric car tracks, save for a small amount of rebracing that had to be done. From Sta. 277 the new grade ascends at the rate of 0.876 per cent. or 46.25 ft. per mile to Sta. 290, where it runs out at the old grade of the tracks.

The tracks in front of the Newton Highlands station were lowered 10.5 ft. and those in front of the Newton Centre station 9.5 ft. These changes of grade necessitated a remodeling of the depots to meet the new conditions. Both stations are of Milford granite and are about 30x75 ft. In both cases the change was made by building new foundations under the front and sides of the building, carrying them deep enough to be below the new subgrade of the tracks. Access to the station from the platform at Newton Highlands is obtained by two flights of granolithic steps, which start on the front at the two ends of the depot and come to a common landing in the centre of the station at elevation of the floor of the station. At Newton Centre, the station being nearer the tracks, there was not room on the front for these steps and a flight of granolithic steps was built at each end of the station and new doors built in the ends instead of on the front as formerly. Paths with a maximum grade of 12 per cent. lead from the streets at each station to the platform.

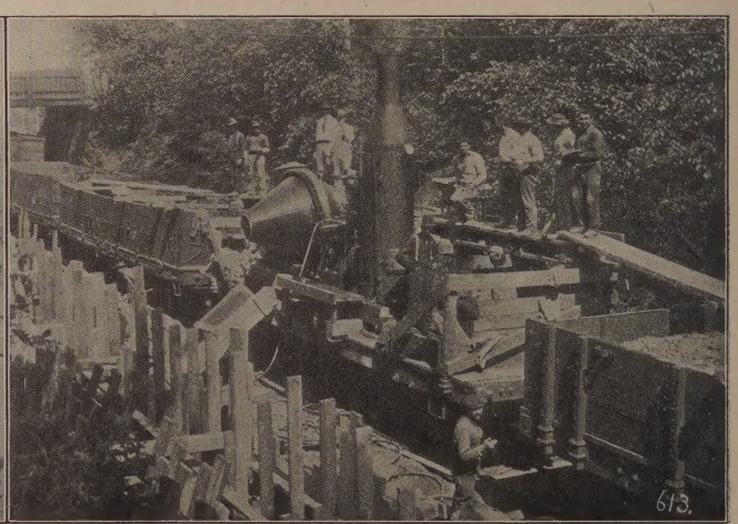
The platforms, in conformity with the standard of the Boston & Albany R. R., are of granolithic construction. The main platform slabs are 4 in. thick; the lower 3 in. is composed of 1:2½:5 concrete; the granolithic finish, 1 in. thick, consisting of 1:1½ mortar colored with 1 lb. of lampblack to each barrel of cement. The front curbing next the track is 24 in. deep and 7 in. thick and is tied to the main platform by two pieces of galvanized iron chain 12 in. long in each slab. The slabs are made to be as near 5 ft. square as is practicable. Where practicable the platform is given a pitch of ⅜ in. to 1 ft. Beneath and in the middle of both platforms a 24-in. drain of Akron pipe was laid to carry the water in the railroad ditch by the station.

At Newton Highlands the baggage is taken from the track level to the street by means of an elevator worked by hand. Outward baggage is also handled the same way. At Newton Highlands the baggage room is in the basement of the station, while at Newton Centre it is handled in a small building, also built of Milford granite and situated about 90 ft. from the station. Baggage coming from the trains is raised from the track to street level by means of a hand elevator. That which is to go on the train is transferred from the street to the platform by means of a granolithic chute.

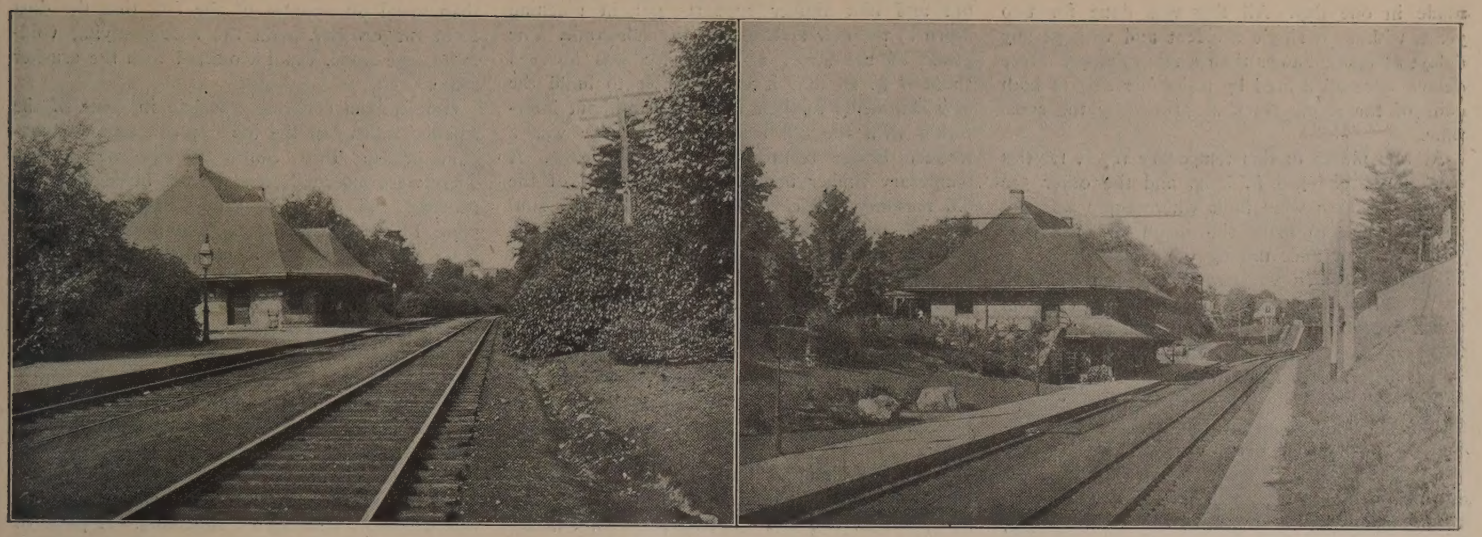
The concrete work on both sides of the track is continuous from Sta. 209 to Sta. 239, and from Sta. 250 to Sta. 280. Where it was not necessary to build a retaining wall to hold the slope a low wall, called a ditch wall, was built to protect the foot of the slope from the anticipated large amount of ditch water to be taken by the depressed roadway. This wall is 2 ft. 6 in. high and is built so that the top of the wall is



Shovel Loading Teams for Street Fills.



Concrete Plant Discharging into Wall Forms.



The Newton Highlands Station before and after Lowering the Tracks.

level with the top of the rail. The ditch is 2 ft. 6 in. below the top of rail and the outside of the ditch at the face of the wall is about 8 ft. 2 in. from the rail. The ditches are all made 2 ft. 6 in. wide. The ditch walls have a foundation 3 ft. deep and are 2 ft. 6 in. thick, made of the same 1:3:7½ mixture of concrete throughout.

Spruce lumber was used throughout for sheathing and bracing, and for forms for concrete. Planks 2 in. thick were used for sheathing. Rangers and braces were usually 6x8 in., although in some cases 4x6 in. were used. For forms in 1905, 2 in. stock was used, planed on one side for face form, unplaned stock being used wherever the work would not be exposed to sight when completed. In 1906, 1 in. stock was used for forms but did not prove as satisfactory as the 2 in., it being much harder to keep it true to alignment and the finished surface, in general, being more uneven.

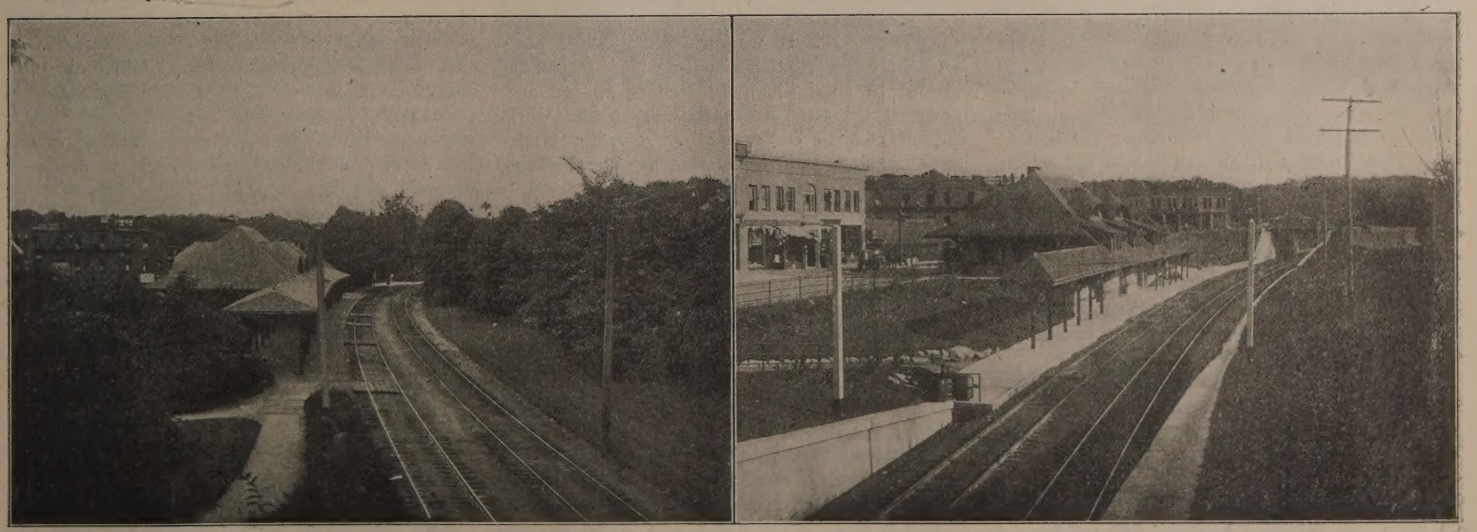
The planks and boards for face forms were fastened together into panels from 12 to 16 ft. long and 2 ft. 6 in. wide. This made it easier for the carpenters in putting up and taking down the forms. They were held in place by 2x4-in. uprights, spaced from 2½ to 4 ft. on centers. Before concrete was laid, the forms were gone over with a plane to remove any uneveness and open joints were stopped up with hard soap.

Lowering the ditches of the railroad a maximum of 14½ ft. at Newton Highlands, and 12 ft. at Newton Centre necessitated the lowering of all drains in the streets which crossed the tracks and some changes in tributary streets. Means also had to be taken to care for the surface water which would fall on the railroad slopes, and from there find its way into the ditches. Fortunately at Newton Highlands Boylston St. and Walnut St. were the only ones which had drains in them. At Walnut St. a new 40-in. circular concrete drain 1,500 ft. long was laid, which emptied into an open concrete drain which was laid 3,000 ft. further to South Meadow Brook. Entrance was made into this drain in both the railroad ditches by means of a special catch basin, in which was incorporated the invert of the 40-in. drain. Under the tracks two lengths of 40-in. cast-iron pipe was laid. This pipe was laid at night at different times so that there might be no interference with trains. At Boylston St. a 20-in. concrete drain was laid, the ditch water being taken care of by catch basins similar to those at Walnut St.

The new grade of the railroad at Crystal Lake being only about 18 in. above the level of the water in the lake, it was necessary to provide some safeguard so that in times of high water the tracks should not be endangered. This was done by building a concrete overflow at the east end of the lake next the tracks, so that should the water ever rise higher than the grade of the overflow the water may be carried off through a drain which passes under the tracks at Centre St. and thence through private lands 2,500 ft. to the lowlands. This drain is of concrete 48 in. in diameter, laid under and built in connection with a ditch wall on the north side of the tracks and carried under them by means of four lengths of 48-in. cast-iron pipe. As soon as the drain passes under the south abutment at Centre St., it is enlarged to 60 in., and is then built of concrete.

Langley Road was the only other street at Newton Centre in which there was a drain, and the work was done in a similar way there, the water from the ditches being taken care of by catch basins. All work on the drains outside of the railroad location was done by the City of Newton by day labor. Newton having the so-called separate system of sewers, the sewers in Walnut St. and Langley Road had to be lowered independent of the drains, temporary means being provided to maintain their flow.

The work at Newton Highlands was started in the spring of 1905, as soon as the frost was out of the ground. There being land enough south of the main tracks to permit it, a temporary line was built the whole length of the work, about a mile and a quarter. Single track was laid on this and the two main tracks abandoned or given up for construction purposes. A flagman was stationed at each end of the temporary track and a third man near the middle had charge of the train movements. The flagmen's cabins were connected by telephones and trains were allowed to enter the single track from either end only by order of the man in charge. There were fifty-two regular trains every day in both directions and to get a train in and out of the single track section necessitated two movements or orders by the man in charge. Often there would be three or four work trains in the section and orders would have to be given putting them into clear so that it was no unusual thing for from five to six hundred movements to be



The Newton Centre Station before and after Lowering the Tracks.

made in one day. All this was done for two years without a single accident and without any delays to traffic longer than a few minutes. Here delays were all caused by trains arriving at both ends of the single track at practically the same time.

At two places in this temporary track, trestles were built, one 368 ft. long, and the other 512 ft. long. These were built where there was not room enough to make the steam shovel cut to grade without undermining the temporary track. Piles were driven varying in length from 6 to 12 ft. They were capped by 12x12-in. caps on which were laid the 10x16-in. stringers. When the temporary track was completed, the traffic was transferred to it and excavation was started with the steam shovel, enough width being obtained on the bottom of the cut at the elevation of the new sub-grade to lay a track which would have clearance from the face of the walls and abutments on the north side. As soon as the steam shovels had a section of the cut completed, the contractor for the masonry work started work on the walls and abutments on the north side. When these had all been completed a track was laid at the new depressed grade, and, traffic being turned on to that, the temporary track was torn up and the steam shovel excavation was made under the site of the other or southerly track, after which the south walls and abutments were built.

The material excavated was disposed of in three ways. Wherever possible it was loaded on teams provided by the City of Newton and used in making the street fills. When this was not feasible, it was loaded on dump cars and used for raising the railroad grade at the fill at Glen Ave. The surplus material was wasted on the company's land at the west end of the work. At Newton Highlands one street, Walnut St., was kept open to teams all the time the work was being done. A temporary wooden bridge was maintained supported by wooden bents, and on the bridge abutments at different stages of the work.

At Newton Centre the right-of-way owned by the road was so narrow there was no room for a temporary track outside the others, as at the Highlands. All abutments and retaining walls on the north side were first built in a trench, the northerly track being given over to the use of the contractor and for construction purposes by the railroad company. All passenger trains were run on the southerly track, making single track in the same way as the year before at Newton Highlands. As soon as the walls and abutments on the north side were completed the same routine was gone through on the south side, the northerly track being used for single track. When the abutments and walls were all completed, which was late in the summer, single-track was again made on the southerly track and the steam shovels, one at each end, excavated about half way down to final sub-grade under the northerly track, this being as deep as they could go and have width enough on the bottom of the cut to lay a track and at the same time not undermine the southerly track. Traffic was now diverted to a temporary track laid in the cut as close to the walls on the north side as was possible, and the steam shovels then excavated under the southerly track to sub-grade. After this was completed traffic was again transferred to the southerly track and the excavation completed under the northerly one.

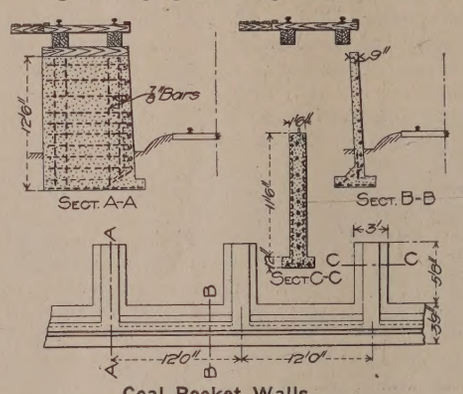
At Newton Centre two streets were kept open to the public all the time until the steel work was put on. Both crossed the railroad on overhead wooden bridges, and the change of grade of course necessitated new abutments and new bridges. One was originally supported on wooden bents and carried an electric car track. The foundation stones of the old bents were taken out and new timber supports put in reaching down to the new elevation of the sub-grade. The grade of the street at this place was lowered about 6 ft. so that it was possible to build the new abutments to their full height without interfering with the old bridge. The bridge was a wooden bridge resting on stone abutments. A temporary timber bent was put in front of the old masonry and carried down to the new sub-grade. The old abutments were then torn out by the railroad forces and the new abutments built by the contractor.

The various mixtures of concrete used on the work were as follows:

All foundation concrete, and that used in ditch walls, was one part of cement, packed in the original package, three parts of sand measured loosely, and seven and one-half parts of broken stone.

Main wall concrete and coping for retaining walls was one part cement, packed in the original package, two and one-half parts sand measured loosely, and six parts broken stone.

Wing-wall coping and bridge-seat concrete was



Coal Pocket Walls.

one part cement packed in original package, two parts sand measured loosely, and four parts broken stone.

Wall facing mortar consisted of one part cement and two parts sand specially screened.

Coping and bridge seat finish mortar consisted of one part cement and one and one-half parts specially screened sand.

The specifications required that the sand should be free from organic matter and should contain not more than 7 per cent. of clay or similar material. The sizes desired were preferably a mixture of coarse and fine, but no batch should consist of wholly fine sand, that is so fine that after having the coarse parts screened out by a No. 12 sieve, more than 50 per cent. would pass through a No. 50 sieve. No dead sand was allowed in the work. The larger part of the sand used both years came from the railroad company's pit at Riverside, about 4 miles from the work. It was provided in the contract for the work that the contractor should be allowed to obtain it there free of charge and it was transported from the pit to the work without cost to contractor. At Newton Highlands excellent sand was found in several places and was used in the work.

At Newton Highlands both broken stone and gravel concrete were used, the gravel being obtained directly from the excavation on the work. Its maximum size was specified as 3 in. At Newton Centre the nature of the excavated material was different, being either filling, peat, silt or hard pan. All the concrete laid at Newton Centre was broken stone. It was required to be free from dirt or dust other than that caused by crushing the stone itself. The size of the broken stone was specified as the entire product of the crusher, including dust, up to and including that which had passed through the crusher screen having a diameter of about 2 in. The amount of sand in the coarse mixture was made smaller than usual on account of the fact that the dust from the crusher, with the accompanying void-filling fine stone, was introduced with the crusher stone.

Hand-mixed concrete was laid in some of the smaller walls, but the bulk of concrete was machine-mixed. Two Smith mixers were used. They were mounted on a flat car hired from the railroad and could be easily transported from place to place as needed. The mixing train as made up consisted of a car of cement and one or more gondola cars each of sand and broken stone. A movable plank runway was laid on top of the gondolas and the sand and stone wheeled in wheelbarrows to the mixer. One of the illustrations shows this very well.

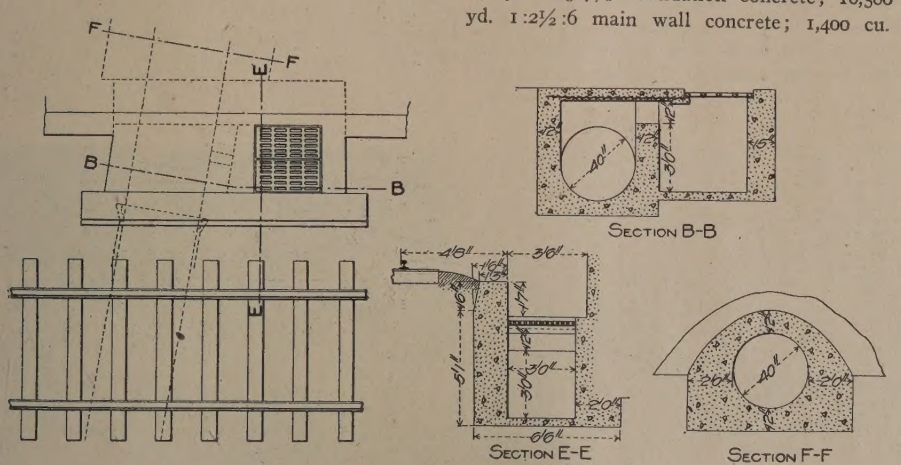
As a general rule the foundation concrete was deposited against the banks without the use of any forms where the nature of the material was such that sheathing was not necessary. Where sheathing was required the foundation concrete was deposited against the sheathing. A piece of plank was placed on the front of the foundation level with the top so that the concrete would be true to grade at the 6 or 12-in. step at the top of the foundation. This was necessary, as this step marked the bottom of the railroad ditch. After the foundation was laid the mixer was moved to another part of the work and the forms for the main wall were built. The moving of the mixer from place to place and the supplying of the two mixers with sand, stone and cement was all done by the railroad free of charge to the contractor and required practically continuous service of one engine and train crew. In depositing the main wall and coping concrete, it was either dumped direct from the mixer into the trench by means of a chute or was dumped onto a platform and then shoveled into place. The 1 in. of facing mortar was deposited at the same time as the body concrete. A metal plate about 8 in. wide and about 5 ft. long was used in placing the facing mortar. On one side of the plate were riveted four 1-in. angles about 7 in. long. A slight flare was given the upper edge of the plate and two handles provided for raising it. This, when placed next the form, insured that there was 1 in. of facing mortar and not several inches as is the case when no guide is used, or none at all in places as is the case when a 7/8-in. board is used. When the top of the plate was reached it was raised up by the handles, and being thin left practically no void to be filled.

In both years there was considerable ledge found in excavation for the walls and the roadbed. This was taken out by the contractor at a yardage price and he was allowed to use it in the walls and foundations as rubble in the concrete. Between different day's work these rubble stone were placed one-half in one section and the upper half left out of the concrete, so that it would help make a bond when the new concrete was laid on the old. When it was not possible to complete a wall at one day's work, horizontal level strips were nailed on the face forms and the concrete brought to the level of these and then stopped. This did away with the irregular streaks which are found on the face when the top of the concrete is left in a rough shape on the face at night. All of the concrete except that laid on an incline, as in wing walls and inclined copings, was what would be called a wet mixture. In some cases it was possible to lay the coping at the same time as the main wall, in which case the dowels were dispensed with. As a general thing, however, this was not possible and the top of the wall under the copings was given a downward, backward slope so that water would not remain on the outside near the face.

After the forms were removed the face was rubbed down and any irregularities chiseled off.

At Newton Highlands the finishing of the face was done as soon as possible after the forms were removed, but at Newtown Centre nothing could be done until after the steam shovel excavation was complete, which in some places was nearly six months later. The face was then thoroughly wet down with a hose and a thin mortar of one part cement and one part sand was applied and thoroughly rubbed in. The face was then smoothed with horizontal strokes of a whitewash brush to give a uniform appearance, free from streaks. This work was made continuous between expansion joints as far as possible, in order to avoid a streaky appearance.

On the south side of the Newton Centre freight yard there was a coal track 12 ft. from the inbound track and leading from it by a trailing point switch. The ground immediately south



Drainage Catchbasin, Boston & Albany Improvements.

of this track was from 5 to 6 ft. lower than the track, which was supported by a wooden cribwork laid on the slope. The coal was unloaded by shoveling over the sides of the cars and letting it fall down this cribwork slope. This was a costly and unsatisfactory way. The railroad was lowered about 6 ft. at this place, which brought the new elevation of the rail about level with the ground in the coal yard. It was decided by the railroad company and the owner of the coal yard that a reinforced concrete wall built to give the same effect as the ordinary wooden coal trestle was what was needed at this place.

The design as worked out consisted of 39 concrete piers 12 ft. on centres, which gives a trestle 468 ft. long. These piers are 18 in. thick 8 ft. wide and 12 ft. 6 in. high, reinforced with ⅞-in. twisted steel bars. The construction above the piers is the same as for a standard coal trestle. On the pier is laid a 10x12-in. hard pine cap, which supports the 8x16-in. hard pine stringers, four in number, two under each track, on which are laid the track ties. Between the piers a thin curtain wall was built to prevent the coal from falling onto the main track. This wall is 9 in. thick, and has a spread base of 3 ft. 9 in. in width.

After the work was started in 1906, it was found that for a part of the way under the wall the bottom was soft, so it was decided to put a pile foundation under a portion of the wall. Four 20-ft. spruce piles were driven under each pier and 9 in. of concrete was laid around the heads of the piles. This was done under a separate contract. The elevation of the coal track was made 4 ft. higher than it was before, and the approach to it is by a 4 per cent. grade. The approach track is laid on an ordinary concrete wall. The clear depth below the coal track rail to the ground beneath it is 12 ft., which gives a chance for teams to be filled by dumping direct from bottom dump cars or, when necessary to unload the cars, they can be dumped direct, and if a greater storage capacity is desired the coal can be shoveled over the sides of the cars. This is the case at the time this is written; coal is piled up on the yard side of the trestle so that it is level with the top of a coal car.

The work was done by contract on a unit price basis for earth excavation, for sheathing and bracing, for concrete, etc. The price for the various mixtures of concrete included the cost of the forms, as estimated by the contractor. The final total quantities on the work were as follows: 33,500 cu. yd. earth excavation; 2,500 cu. yd. rock excavation; 8,000 cu. yd. backfilling; 300,000 ft. B. M. spruce sheathing and bracing, placed and removed; 114,000 ft. B. M. spruce sheathing and bracing left in place; 6,600 cu. yd. 1:3:7½ foundation concrete; 16,500 cu. yd. 1:2½:6 main wall concrete; 1,400 cu. yd.

Constructing a Side Wall with Cableway at Newton Highlands.

1:3:7½ ditch wall concrete; 550 cu. yd. 1:2:4 bridge seat concrete; 230 cu. yd. cut stone for bridge seats.

The work in 1905 was done by Chas. R. Gow and John E. Palmer under the firm name of Gow & Palmer. The work in 1906 and 1907 by the Chas. R. Gow Co., of which company Chas. R. Gow is president. The excavation and all other work done by the railroad forces was in charge of the roadmaster, C. B. Lentell. The work was done under the direction of Mr. Walter Shepard, chief engineer, Boston & Albany R. R.. Mr. William Parker, division engineer, was directly in charge of the work. The detail plans were made by the writer, who also had charge of the line and grade work, estimates and construction work under the direction of the division engineer.

Sewage Purification at Hampton.

The method of sewage purification now employed at Hampton, England, is so favorably regarded by British engineers that some statements concerning it by Mr. Sidney H. Chambers deserve attention. He is the surveyor to the Hampton Urban District Council, and at a resent meeting of the Association of Municipal and County Engineers explained a marked change made in the operation of the system as follows:

The original method of working the Hampton contact beds was to exclude nothing from them, except the screenings, and to endeavor to retain the suspended matter in them, in the confident hope that all would be destroyed. The result was that, in 1902, after four years' operation, so much sludge had been removed from the beds, and so much was retained in them, as to give rise to the opinion that the original suspended solids had either suffered no diminution by biolysis, or whatever diminution had been effected had been made up from some other source. The opinion was confirmed two or three years ago by careful estimations and calculations, and more recently by estimating the total amount of sludge removed in washing the beds.

The present method of working the beds is to exclude from them the largest possible quantity of suspended solids, and as much of the colloidal matter as will readily be removed from solution by large surface contact, while at the same time the beds are so operated as to secure the disengagement and evacuation of as large a proportion as possible of those solids which have entered them, or which may be formed therein from the soluble solids. By this method of working the desolution effect is made evident, since the total amount of suspended matter leaving the beds is in excess of those gaining admittance thereto. The effect of this throwing out of suspended matter is, obviously, to minimize the accumulations, which necessarily must prolong the working efficiency of the beds.

STEEL WATER MAINS 4, 6 and 9 in. in diameter have been used in the new works to furnish an additional supply to Teignmouth, England. The original plans of Mr. C. F. Gettings, the urban district engineer, called for cast-iron pipe, but a considerable saving was made by using steel pipe furnished by the British Mannesmann Tube Co., as the pressures carried are quite heavy, running up to 380 lb. at a river crossing.

Conditions along the Panama Canal.

From the annual report of the Isthmian Canal Commission, made public this week, and the "Canal Record," the official journal of the Commission, it is possible to form a good idea of conditions along the Panama Canal. During this year the entire personnel was changed, and to the vacancies left by the resignations of the former members were assigned three officers of the Corps of Engineers, United States Army; the Chief of Bureau of Yards and Docks, United States Navy; an officer of the Medical Corps, United States Army, and two civilians. Two important changes resulted from a combination of the positions of chairman and chief engineer on March 4, filled by Lieut.-Col. Geo. W. Goethals, and from the requirement that the Commissioners take station on the Isthmus, where they can be in direct touch with the work committed to their charge. The new Commission assumed its duties on April 1, 1907.

In order to utilize the services of the engineer members of the Commission in construction work and to secure a closer supervision of the details of the work, then rapidly expanding, through a head directly responsible to the chairman and chief engineer, the department of construction and engineering was subdivided into departments, each in charge of a member of the Commission, as follows: Department of excavation and dredging, department of lock and dam construction, department of municipal engineering, motive power and machinery, and building construction.

Excavation and Dredging.—This department of construction embraces the Culebra division, extending from the Chagres River to Pedro Miguel, the Chagres division, embraced between deep water in Lake Gatun and the Chagres River, the Colon dredging division, extending from Gatun to deep water in the Atlantic, and the La Boca dredging division, taking in all excavation between the La Boca locks and deep water of the Pacific.

The Culebra division is practically 10 miles in length, and early in the wet season it was recognized that general supervision of all the steam shovels or all the trains of the entire division under one supervisor or superintendent was not productive of the best results in fixing responsibility in case any part of the work was not progressing satisfactorily, consequently a slight change in organization was effected on July 1. This consisted in subdividing the division into five construction districts, each under charge of a superintendent of construction, who is held responsible for the work in his district. Better results have followed with less friction.

The greatest difficulty found in maintaining the output during the rainy season is due to the dumps; the material being loose sinks under train loads after being wetted by the heavy rains causing considerable delay if not entirely preventing the use of the dump until it has dried out.

The total excavation in this division up to November 1 has been 11,221,730 cu. yd. The average haul of the dump trains is about 10 miles at present, but will be increased when the soil goes into the dams, as described later. On June 30 there were 3 45-ton shovels, 28 70-ton and 32 95-ton on the Isthmus. The number of cubic yards excavated per hour, while under steam, by shovels not engaged in preparatory work, averaged 68 for the fiscal year ending June 30, 1906, and 86 for the year ending June 30, 1907. Considering the total output in the Culebra division for the fiscal year, the average cost of the various items of expense have been as follows: Arbitrary, to cover cost of plant, $0.1200; blasting, .1451; excavation by steam shovels, .1081; transportation, .1942; tracks, .0830; dumps, .1548; general expense, .0193; total, $0.8245.

This does not include the material used in the repair of locomotives, steam shovels, and cars, nor does it include the cost of operating the air compressor nor the proportionate cost of administration and general expenses of the mechanical department, which makes repairs on plant for the Culebra division. These items have never heretofore been included in the cost of excavation in the Culebra division, but as they comprise a fair charge against this work, they will be included in the cost of work for the fiscal year ending June 30, 1908.

In the costs just given the total cost of blasting has been distributed among the total number of cubic yards of excavation, but to get the real cost it should be applied only to the material actually mined, 3,291,856 cubic yards, making the cost for blasting $0.2557 per cubic yard. In other words, other things being equal, the removal of rock, due to blasting alone, cost $0.2557 more than that of earth.

General View of Culebra, the Canal Headquarters.

The item entitled "Arbitrary, to cover the cost of plant," is a fixed charge added to the cost of excavation with the idea that this fixed charge added to every cubic yard of material excavated will, by the time the canal is completed, total a sum which will be equivalent to the original cost of the plant, repairs for the plant being included in the cost of operation.

On the Chagres division only preparatory work was done during the year, consisting of surveys and borings to determine the character and amount of earth to be removed. The Chagres River crosses the center line of the canal 23 times within the limits of the division. The differences of level between the river and portions of the division are such that whatever excavation in the dry is undertaken will be subject to more or less interruption from overflow during the wet season. As the rock portion of the cut can be removed or broken up by blasting more economically in the dry than in the wet, it is desirable that work be undertaken without delay; though the amount to be done is relatively not large, the conditions are such as to militate against rapid progress.

The Colon dredging division consists of the Mindi and Colon districts. In the former about 700,000 cu. yd. of material in the vicinity of Mindi Hills will be removed by steam shovels, this method being more economical since the borings made during the fiscal year indicate that a large percentage of rock is found in this locality; the remainder will be dredged. The necessary clearing and other preparations were made and excavation by steam shovel was begun toward the close of the year.

In the Colon district dredging operations were in progress throughout the year, the greater part in the vicinity of the dry dock slip and along the route of the old French canal as far as Gatun. The latter was done to make a navigable waterway for the transportation of the materials that must be taken to the site for the construction of the locks. The machine shop for the Colon dredging division at Cristobal was equipped during the fiscal year with many pieces of new machinery and is in good working order. Steps were taken to enlarge the dry dock so that when completed it will be capable of taking a vessel 298 ft. long, 50 ft. beam, and 15 ft. draft.

On the La Boca dredging division the surveys to determine the line of the canal were completed, and some dredging done. The machine shop at La Boca is fairly well equipped for marine work and has accomplished much in rebuilding and repairing floating equipment, such as clapets, launches, barges, and electric cranes.

Locks and Dams.—This department of construction embraces the Gatun locks and dam, the locks and dam at Pedro Miguel, the locks and dams at La Boca, meteorology and river hydraulics.

The locks are in pairs, each, as now proposed, with usable lengths of 1,000 ft. and widths of 100 ft., which there is some talk of increasing to 110 ft. The adopted project contemplates a flight of three locks at Gatun, a flight of two at La Boca, and one lift at Pedro Miguel. The report on the site of the locks made by Messrs. Noble, Stevens and Freeman, already printed in this journal, stated that all of the locks of the dimensions proposed will rest upon rock of such a character that should furnish a safe and stable foundation. Since this report was made last May careful borings have been continued over the entire area in order to secure a contoured plat of the rock surface with a view to the most economical adjustment of the locks to the site.

Subsequent to the adoption of the project, studies were begun of locks, gates, and sluiceways. From these studies the Commission finally decided upon the method of filling and emptying the locks and the number and type of gates. The gates are in duplicate and of the miter type, except that the rolling gate similar to that now in use on the Ohio River will be substituted for the duplicate set at the lower end of each sum-

mit-level lock. In addition there will be provided an auxiliary pair of gates at the lower end of each flight for use as cofferdams in case it may be necessary to pump out the locks, and it has been determined tentatively to adopt a swing bridge type of dam for emergency use. The designs for the locks and gates are progressing satisfactorily.

Gatun Locks and Dam.—Excavation of the lock site by steam shovels was begun in September, 1906. About 573 acres of the site to be occupied by the dam were cleared of timber, and a pile trestle was partially driven along the 30-ft. contour on the upstream toe of the dam for the purpose of depositing rock from Bas Obispo as an integral part of the dam. Contracts were entered into for two 20-in. pipe line suction dredges for construction use on the lower portion of the dam. The cross section of the dam has been slightly changed and the upstream slope made more gradual than that originally proposed.

Broken stone needed for concrete construction in the locks can not be obtained in the immediate vicinity of the site and a quarry of trap rock suitable for the purpose was located at Porto Bello. Surveys of the property were made, and contracts were entered into for furnishing the necessary rock-crushing plant and barges for transporting the product to Gatun.

At the Pedro Miguel locks and dam, besides the pits and borings to determine the character of the foundation, work was confined to excavating the lock site.

At the La Boca locks and dams only preparatory work has been in progress, consisting of borings at the lock site and along the lines of the La Boca-San Juan dam and the Sosa-Corozal dam, and for locating and constructing the necessary spillway. At the Sosa-Corozal dam preparations were made for the construction of trestles on the two toes of the dam from which material from Culebra cut is to be dumped. Between the two dumps thus made suitable material for the dam is to be placed. Arrangements were made for the construction of a diversion channel for drawing off water which interferes with the construction of the dam so begun.

Division of Municipal Engineering.—The work performed by this division during the fiscal year included the paving of streets and construction of water works and sewer systems in the cities of Panama and Colon, paving, roadmaking, grading, construction of waterworks and sewer systems, and miscellaneous work of a similar nature in the Canal Zone, necessitating an expenditure of $1,741,953, divided about equally between work in the cities of Colon and Panama and work in the Canal Zone.

In general, the work has been but a continuation of the plan inaugurated at the outset of American occupation of the Isthmus—to take such steps as were necessary to make the Isthmus sanitary, so as to further the work of building the canal.

The cost of work done in the cities of Colon and Panama will be reimbursed to the United States under the terms of contract entered into shortly after the expiration of the fiscal year, in which the United States is authorized to collect such water rates as are sufficient to reimburse itself, as above outlined. The cost of these improvements in the cities of Colon and Panama, covering work approved to date, will approximate $1,750,000.

Division of Motive Power and Machinery.—The work embraced the erection and preparation for service of machinery necessary in canal construction and its maintenance in good repair; the installation and operation of air-compressor plants; the performance of work in connection with electrical installations, and the manufacture and repair work for other divisions.

To date the following machinery has been erected and made ready for service: Sixty-three steam shovels, 284 locomotives, 2,076 dump cars, 18 unloaders, 13 bank spreaders, 33 unloading plows, 3 track shifters and 7 pile drivers.

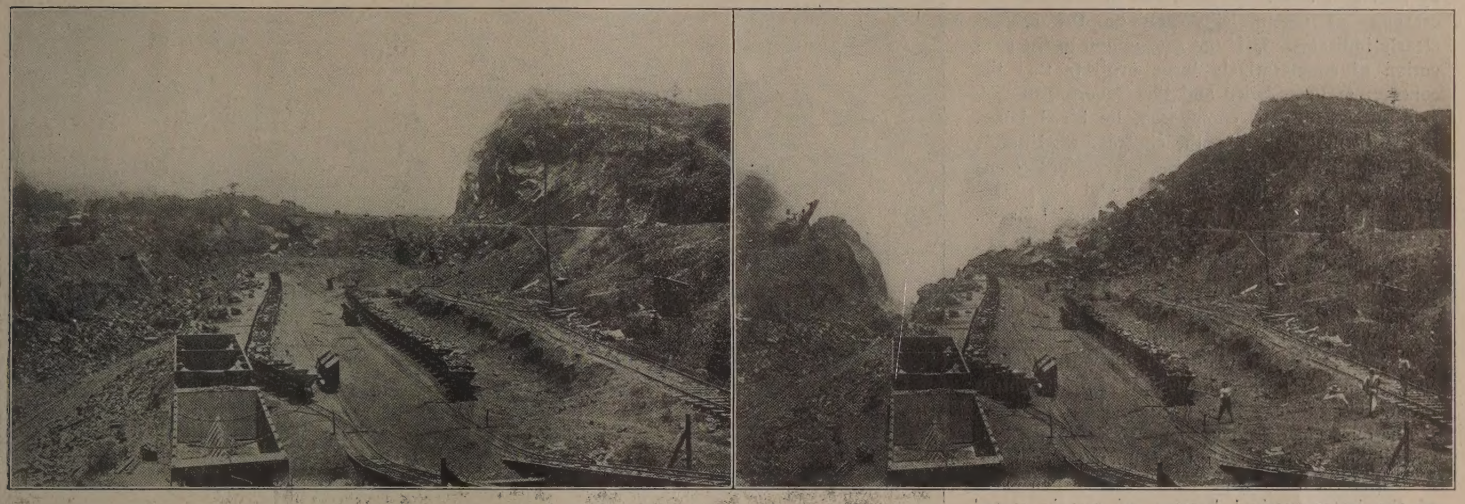
This work has been done largely at the old plants at Cristobal, Gorgona, Empire and Paraiso. Work was commenced on new plants at Empire and Paraiso during the year, in order to provide for increased demands made on this division.

Building Construction Division.—For the accommodation of gold employees 656 quarters, both bachelor and family, were constructed, and for silver employees 335 buildings were erected, consisting of barracks, bath houses, cook sheds, family quarters and kitchens. For the sanitary department 33 buildings were constructed for hospital purposes. Larger office buildings were constructed at Empire and Ancon and additional office space afforded at Cristobal and Culebra. A school building was constructed at Culebra, and other buildings for similar purposes started at Gatun, Cristobal and Empire. Seven mess halls for the accommodation of American employees and 11 for European laborers were completed; a large hotel at Tivoli Hill was also built, together with quarters for help and baggage room. A machine and car-repair shed, machine shop, engine house, pattern shop and other structures for the manufacture and repair of machinery were completed and extensive plants at Paraiso and Empire were commended. Four clubhouses were constructed.

Of the 2,265 buildings which were received from the French Canal Company, 252 were repaired during the year and 113 destroyed. There are 678 of these buildings yet remaining to be repaired, remodeled or demolished.

Division of Material and Supplies.—The division of material and supplies, the head of which reports directly to the chief engineer, is charged with the purchase and the proper handling of all material and equipment needed in connection with the construction of the canal. The diversity of the work necessitates the purchase and use of a very great variety of equipment, material and supplies, including stock for repairs. All departments on the Isthmus rely upon this division to suppply their various wants, and every effort is made to anticipate requirements by frequent purchases in the United States based on estimates submitted by the different divisions or gauged by the rate of consumption of stock on hand at the various storehouses along the line.

A large amount of old French material, consisting of boilers, pumps, Decauville track, cars, locomotives, cranes and other material, has been repaired and placed in service. About 11,000 tons of this old French material were disposed of to dealers in the United States as scrap iron, and 4,000 tons of it were used as ballast by Panama Railroad vessels going north, when there was a shortage of commercial cargo.



Views before and after a Blast Displacing 29,640 Yards of Rock at Bas Obispo.
Four drill holes, 78 feet deep, were used and charged with 9,600 pounds of black powder.

Storehouses for the distribution of this material are located at Mount Hope (general storehouse), the dry dock, Cristobal, Gorgona, Bas Obispo, Empire, Culebra, Paraiso, Ancon and La Boca. Larger and more commodious storehouses are under construction at Empire and Paraiso. All storehouses carry as full a line of supplies as is carried at the general storehouse.

The New Panama Railroad.—The completion of the canal will necessitate the abandonment of the present main line of the Panama Railroad, and preliminary surveys for location of a new line on the east side of the canal have been completed. The location of the line was practically determined in March, and involves the excavation of 1,600,000 cu. yds. of material and the placing of 12,000,000 cu. yds. in embankments.

The main line at Gatun now passes over a portion of the site that must be occupied by the dam, and in order not to delay work on this structure it became necessary to commence so much of the new line around Gatun as would enable the abandonment of the existing line and permit construction of the dam upon this portion of the site.

Contract vs. Hired Labor.—The report of the Commission discusses this subject at much length. There is no question, the report states, that in the majority of cases in the United States work is

contracted because it can be done cheaper by that method than any other. This is generally due to the fact that the contractor has on hand a construction plant which can be more cheaply hired than purchased anew. Where, in any particular case, either from the nature of the work or its location, the contractor must purchase machinery and appliances which, so far as he can forsee, will be practically useless on the completion of the work, or where the party having the work done can make use of the plant subsequent to its completion, the advantages of the contract system disappear.

As illustrative, the Government secured cheaper and incidentally better concrete work in its fortifications than was obtained by contract. The batteries are heavy concrete constructions requiring machinery for which the contractor could find little, if any, subsequent use. For the same reason the Government, in many cases, especially where the work was removed from commercial centers, was able to construct locks and dams more cheaply than could a contractor. In some instances, to overcome a combination of contractors, the Government purchased the necessary plant and accomplished results more cheaply than by contract; this is notably true in dredging operations, as recent legislation on the subject clearly indicates. It is not uncommon in the execution of comparatively large projects that the contractors have failed and the Government carried successfully to completion, by hired labor, the work undertaken by the contractor. Notable instances of the Government successfully completing work are the State, War and Navy Department building and the Congressional Library, Washington, D. C.

Omitting profits derived from subsistence and general stores, and assuming the hours of labor the same in both cases, it stands to reason that the Government, when warranted in making the necessary outlay for plant, can do work cheaper than a contractor, for no question of profits enters into consideration.

The question of Government work versus contract in connection with the Panama Canal has been discussed, and a conclusion reached in favor of the latter method because of certain stated advantages that are claimed to result. To those familiar with river and harbor improvements, erection of public buildings, lighthouses, etc., and with contracts under the Government the advantages set forth are not so apparent or real, according to the report.

It is claimed that contractors have under their control and at their disposal trained labor forces, and that by a combination of such forces, through an association of contractors, team work will result, thereby accomplishing the desired end more quickly. As a matter of fact, conditions seldom enable a contractor to maintain intact his entire organization on one piece of work for transfer to another; the completion of a job means the disbanding of the force, and though new work may bring to him some of his old men, a new organization must in each case be perfected.

The Panama Canal presents a piece of work unprecedented in magnitude, which must be done under conditions entirely different from similar classes of work in the United States. The work naturally divides itself into dredging, dry excavation, the construction of the locks and dams and the construction of the new Panama Railroad. There is no contractor or syndicate of contractors that by any combination could bring to the Isthmus an organization ready for team work on any of these units. While it is possible for several contractors to combine forces, assuming that a sufficient number of men can be gotten together in that way, there still remains the necessity for whipping this force into shape in order to secure an organization that will produce the team work so advantageous in the accomplishment of results.

From the United States the supply of labor is the same whether the work be done by contract or by the Government, and the character of the labor must be the same. So long as work is plentiful the dread of the Tropics will deter men from seeking work here in preference, and this is equally applicable to the contractor and the Government. An adequate supply of labor from the United States is not possible, and recourse must be had to securing it abroad. The records here show that no contractor can even attempt to recruit labor in the West Indies, and that great opposition will develop to any recruiting by authorized agents of the Commission if the labor procured is turned over to contractors. These island governments cannot be blamed for their hostility toward the latter because of their experience under the French, which left an indelible impression throughout the West Indies. A representative of the Italian Government has recommended to the authorities that Italian labor be permitted here for employment under the commission, but he is not favorably inclined to the control of such labor being vested with a contractor.

It is true that in some cases the contractor may have an acquaintance which will enable him to secure suitable men more easily than a government agent and, again, he may bring to a work a great experience, but, so far as the most important parts of the Panama Canal work are concerned, this advantage is not apparent. In any case, the knowledge of the specialist in the particular work that is to be done is the element that will accomplish the most satisfactory results, and, so far as dredging and lock and dam construction are concerned, the government's experience has been, if not greater, at least as extensive as that of any contractor or association of contractors that can be secured in the United States. For these units of the work the government's acquaintance is equally extensive, and experienced men can be drawn from the engineering force of the government. These three classes of work form the most important parts of the Panama Canal, and in their prosecution the government has the advantage. So far as relates to excavation in the dry by steam shovel and cars, the advantage ordinarily would be with the contractors, yet the government has secured and maintained an organization on the Isthmus that cannot be surpassed by any contractor, and, it is claimed, has perfected this organization in as short a time as, under the circumstances, could have been done by any association of contractors.

When the government does work in the United States the wage scale is determined by the amount paid for the same class of labor in the immediate vicinity; there is no pressure brought to bear on higher authority for any increase over the salaries or amonuts offered, and strikes are unknown. It is true that conditions on the Isthmus are such that demands for increase in pay are frequent, and that to accomplish what was denied by those immediately in charge of the work recourse has been had to higher authority.

Conditions on the Isthmus are peculiar. It is contended, apparently on reasonable grounds, that service in the Tropics saps the energy, and that a man is incapable, after a time, of performing the same amount of work that he would accomplish had he spent the same period in a cooler climate. This creates a desire to accumulate sufficient means to avoid the necessity of relatively harder work on the return to the United States, and it is a question that a contractor would be obliged to face as well as the United States. In some respects the government is in a position to handle the situation more satisfactorily than a contractor, as was plainly shown by the trouble with the steam-shovel men in May last.

Track Throwing Machine on the Tabernilla Dump.

The wage scale on the Isthmus is practically adopted, and a contractor would be obliged to maintain it. Under the recent decision that all questions of pay are to be left with the commission, this body is placed on as secure a basis relative to the constant demands for an increase as any association of contractors.

Experience has shown that continuity of construction is more apt to result in cases where the government undertakes the task than when it is turned over to contractors. This can be easily verified by an examination of the records (the number of failing contractors) to be found in the office of the Chief of Engineers. For all work done by hired labor continuity of work is merely a question of continuity of appropriations. It is true that continuity may be equally insured by turning the Panama Canal work over to contractors, if the contract is so drawn that practically all risks are assumed by the government, but why this should be done, at a considerable increase in cost, is not apparent.

To any one who has had experience with contracts on government work, the claim that letting a piece of work by contract is a reasonable assurance that it will be completed in a definite time is utterly untenable. On public works, including public buildings, it may safely be said

that in the majority of cases the time limit is exceeded. An examination of the contracts for material to be supplied the Isthmian Canal, so far as the time limits proposed by the contracts are concerned, will clearly show that there is no assurance of completion in a definite time of any contract, even though the contractors themselves, when fully cognizant of all the conditions surrounding the work, fix the time for the completion or delivery. It certainly cannot be supposed, therefore, that in an enervating climate, like that on the Isthmus, and with labor below that in the United States in efficiency, this time-failing record for contract work would be changed.

Reasonable definiteness in cost is usually obtained by contract, when based on unit prices and when all conditions of the work are fully known in advance, yet these unit prices are, as a rule, higher than would be the cost to the government should the latter possess the necessary plant. It is true that the contract which was proposed for the construction of the canal provided for the determination of time and cost by a board of engineers, but the conclusions on these points could be upset should conditions be found or met with unforeseen by that board. Experience on all works, even those based on more definite data than can be presented to contractors for the Isthmian Canal work, shows that the unexpected is always happening, and this seems especially true of the work here.

There is no question that there are a number of people who will always believe and contend that any piece of work done by the government could have been done as well and more cheaply if undertaken by contract, but an examination of the records will generally disprove such a contention. On the other hand, there is an equally large class who will contend to the contrary and claim, after the completion of the work that the reverse is true.

Work heretofore has been conducted on a non-partisan basis. The thinking class of American people fully realize the necessity for the Panama Canal and its early completion, and it is generally realized that this can be accomplished only by the application of business and non-partisan methods. This has generally been the case with all government work wherever undertaken, and the fact that the continuation of this policy may not continue along the same lines is hardly an argument strong enough to weigh in favor of contract work.

While it has been noted that contractors can usually do work cheaper because of plant already on hand, thereby saving the cost of new machinery, and because of greater familiarity with the class of work on which they are engaged, there are at times additional ways for securing the same results, namely (*a*) by paying lower wages, (*b*) by working their men longer hours, (*c*) by requiring a greater amount of work per hour from the men, (*d*) by giving them less expensive rations and quarters, in case employees are fed and quartered.

On the Panama Canal a contractor cannot anticipate profits from any of these sources. The work already done and in progress has fixed the wage scale, and a contractor would be unable to retain labor that might be turned over to him, nor could he secure additional men at less salary than already paid by the commission.

The government is now working foreign labor as many hours per day as is practicable in this climate, so the contractor could gain nothing more than the government has already acquired. So far as American labor is concerned, the eight-hour law is applicable, and so long as it remains in force it must be as binding on the contractor as on the government.

It is questioned whether he could get more work out of the laborers on the Isthmus than they now perform for the commission. This is a question dependent entirely upon the character of foremen employed, and he would have exactly the same class of men in this position, since most of the foremen now employed have previously been with contractors, and therefore have had their principal training on contract work. Moreover, the pace set by the laborers under the commission would fix the rate for the contractor.

Were all the work turned over to one contractor, or an association of contractors, the Commission would be obliged to maintain a supervisory force, and the feeding and quartering of these employees would determine the demands that the contractor's men would make upon him for accommodations. Moreover, a number of the dwellings that are now occupied by Commission employees would be turned over for occupancy by contractor's men, and any additional force would expect the same accommodations. Trouble would result, therefore, in case the contractor fed his employees on less expensive rations or quartered them less comfortably than the Commission; no saving could be made, and the Government would be obliged to foot the bills.

The Panama Canal work is naturally divided into—

(1) Excavation in the dry by steam shovel, including all of the Culebra division and part of the Chagres division. The construction of drainage and diversion channels would come under this heading.

(2) Excavation by dredges on the Colon and La Boca divisions and on part of the Chagres division.

(3) The construction of the dams.

(4) The construction of the new Panama Railroad.

(5) The construction of the terminal facilities, harbor basins and breakwaters, if any.

(6) The construction of locks, gates and spillways.

The excavation of the Culebra division has already been undertaken by hired labor; practically all of the plant required for this work has been secured and paid for; a complete and thoroughly efficient organization for the same has been built up, and the Government is not hampered in any way in procuring the necessary labor for filling vacancies that arise. In the organization that has been perfected the higher grade men were formerly employed by contracting firms, and some of the number have been successful contractors themselves. The conduct of this work, therefore, has been along the lines usually followed by contractors. Under the circumstances no advantage would accrue to the United States by letting this piece of work to contractors, but on the contrary there would be not only additional expense, but a feeling of unrest and dissatisfaction engendered among the present employees materially affecting efficiency. Under existing conditions, therefore, contract work cannot be recommended for the Culebra division.

The Government has on hand, or under contract, all the dredges that will be needed for excavating such parts of the canal prism as can be most economically performed by this class of machinery. Experience in the United States has demonstrated that with such a plant in its possession no contractor or association of contractors can do the work as economically as can the Government. The Government agents are as familiar with this class of work as the contractors, and the necessary dredge crews can be obtained without difficulty. So far, therefore, as dredging is concerned, the Government should do the work and contracts for the same cannot be recommended.

The great problem in the construction of that portion of the canal included in the Culebra division is the disposal of the excavated material. In the main this has been disposed of at various localities favorably situated with regard to the cut. The systematic performance of the work and the necessity for additional material in completing other parts of the work have made it necessary to arrange for such a disposition in the future as will be most beneficial to the work in its entirety. The efficiency of the dams depends upon their having sufficient weight and tightness to impound the water without leakage and without danger to the stability of the structures. The weighty material, or rock, is to be furnished in each instance by material from the Culebra cut and the tightness is to be secured by the selection of suitable material to be obtained from the products of dredging. In other words the construction of the dams is so intimately connected, both with the excavation of the Culebra cut and the dredging, that if these two can be most economically and advantageously done by the Gov-

Spreading Material on the Corozal Dump.

Excavation on the Culebra Cut near Gold Hill.

ernment rather than by contract it naturally follows that the method adopted for the construction of the dams must be the same, namely, by hired labor under Government supervision and not by contract.

The survey of relocation for the Panama Railroad has been completed and it has been necessary to undertake the construction of the railroad in order to permit the removal of the present bed in the vicinity of Gatun, so that the construction of the dam at that point may be begun. The construction of the new line requires, among other things, about 1,600,000 cu. yd. of excavation and about 12,000,000 cu. yd. of embankments. The excess of embankments over excavation, about 10,000,000 cu. yd., is to be supplied largely, if not entirely, from material excavated from the canal prism, the embankments forming dumps for the material trains. Steps have already been taken for the development of dumps which will result in the construction of a part of the new roadbed at Miraflores, Pedro Miguel, Gamboa and Gatun, and plans have been prepared and proposals invited for a bridge across the Chagres at Gamboa. With excavation in the Culebra division to be done by hired labor under Government supervision, with the material therefrom to be used in the construction of the Panama Railroad, the intimate relation between the two necessitates the adoption of the same method of construction, namely, hired labor under Government supervision, in the consctruction of the new Panama Railroad.

The regulating works and spillways of the Gatun and La Boca dams are so dependent upon and intimately connected with the construction of the dams that whichever method is adopted for the latter must be made applicable to the regulating works and spillways, in order to avoid friction and difficulties that would result in case part were done by the Government and part by a contractor.

The Panama Railroad must be maintained and operated as a commercial line, and it must be utilized also for construction purposes in connection with the Culebra cut, the reconstruction of the railroad, the construction of the dams, and in addition it must transport all materials entering into the construction of the Pedro Miguel locks.

The difficulties that would result from a joint use of the Panama Railroad by a contractor and the Government at the Pedro Miguel locks disappear, however, for the locks at Gatun and La Boca, since both are accessible by water. Sand can be procured along the shores of the Pacific, and a suitable quality in sufficient quantity can also be obtained on the Atlantic shore of the Isthmus.

The success of the lock construction depends largely upon the quality of cement used, and there is no question that the Government should furnish all the cement. No contractor, or association of contractors, possesses the necessary plant for handling the enormous quantities of concrete required for these structures. Subsequent to the construction of the locks the contractors could have no further use for the machinery installed, even if the payment of freight for its return to the States were warranted. If the contractor furnishes the plant, the Government must pay for it in its entirety and in addition pay interest on the amount expended for its purchase. This plant can be procured more cheaply by the Government than by a contractor. As previously explained, if the Government furnishes the plant, the advantage of the contract method disappears. The contractor will have greater difficulty in securing the common labor needed than will the United States. The engineering force of the Government that has in the past few years been employed in the construction of such large quantities of concrete in various forms in the United States can be drawn upon to furnish the skilled personnel necessary for concrete work here. The acquaintance with competent men, for this class of work, is more extended on the part of the Government than on the part of the contractor.

These considerations lead to the conclusion that the locks can be more economically and advantageously constructed by the Government than by a contractor or association of contractors.

The gates and operating machinery can, it is believed, best be constructed by contract at the proper time.

The foregoing conclusions do not cover the proposed work on the Chagres division or the terminal facilities, harbor basins and breakwaters, as the surveys for the development of the amount of work and character of material involved in the Chagres division have not yet been completed, nor have the final plans for terminal facilities, etc., been finished.

No account has been taken of the question of sanitation, one very important to the successful prosecution and completion of work on the canal. Proper sanitation can be maintained more easily and satisfactorily with the Government in supreme control of the work than with a contractor, and this adds an additional argument in favor of the Government doing the work itself.

The relative advantages of the contract system versus hired labor under Government supervision in the construction of the Panama Canal are very different to-day from what they were two years ago, and were different then from what they were when the work was first undertaken. To one familiar with conditions on the Isthmus there can be no doubt at this stage of the work as to the advisability of continuing it by hired labor.

It is estimated that 80 per cent of the entire plant needed for the construction of the canal has been purchased or contracted for. Machine shops have been erected and equipped for making all needed repairs to the machinery now on hand or still required for the work. So far, therefore, as the plant and its care and repair are concerned, the Government is better equipped to carry on the work as advantageously and economically as any contractor.

Many thousand employees have been secured, and an effective working organization has been perfected, and the recruiting system put in operation is capable of furnishing more labor than can be advantageously used. The employees are well sheltered and, in general, well fed; the salaries paid are satisfactory and the work is progressing smoothly. A change from these favorable conditions in the method of prosecuting the work would disorganize all existing conditions and would undoubtedly increase the estimated cost and time of completing the canal.

The conclusion that the work can be done better, cheaper and more quickly by the Government has been reached only after free and full discussion by the various members of the Commission and the higher officials connected with the construction work, and after careful consideration of all sides of the proposition.

Labor, Quarters and Subsistence.—This department is charged with securing all skilled and unskilled labor and its assignment, according to the needs of the work. It is the custodian of all living quarters, allotting them to employees according to their standing as gauged by salary earned and in conformity with rules and regulations approved by the Commission.

It supplies furniture to quarters, delivers distilled water to residences, offices and shop, and is in direct charge of the delivery of all food supplies, including ice, bread and cold-storage articles from railroad stations or local commissaries to residences, hotels, messes and kitchens.

It polices the ground around camps and quarters, cleaning up waste and refuse material which is placed within reach of those charged with its final disposition. It also has charge of the lighting of the camps and of roads to and through them.

It operates the hotels, messes and kitchens for the accommodation of the employees of the different grades—the hotels for white Americans, the messes for Europeans, and the kitchens for the natives of the West Indies.

It keeps the service history of each individual employee in the general personnel record of which it is the custodian; issues by direction of the chairman all orders pertaining to leaves of absence, sick leave, resignations, discharges, promotions and reductions. It also authorizes the issuance of steamship transportation and special rates to which employees are entitled.

The skilled labor force is recruited in the United States. The skilled force on June 30, 1906, was approximately 2,500, and on June 30, 1907, actually 4,404. To increase this force 1,904 men and provide for the usual separations, due to sickness, resignations, etc., 3,038 men were brought from the United States during the year.

The unskilled force is brought from the West Indies and Europe. Recruiting agents are located in Barbadoes and Martinique, and a representative in Paris, France, to keep in touch with European labor conditions and with European emigration. On June 30, 1906, there were on the canal work 500 Europeans and 13,625 West Indians. June 30, 1907, there were 4,317 Europeans and 14,606 West Indians. To maintain this force of laborers, and also provide the Panama Railroad force of about 5,000 laborers, 6,899 Europeans and 10,947 West Indians were brought to the Isthmus—an average of nearly 1,500 men per month—to meet the demands of the work for common labor during the year.

At the close of the last fiscal year 1,129 houses were available for quartering employees of all classes, furnishing buildings for offices, hotels, messes, kitchens and storerooms. On June 30, 1907, 2,208 buildings were in use for the same purpose.

There are in operation 23 kitchens for the West Indian laborers, where a day's board is furnished for 30 cents and is made up of such food supplies as they are most accustomed to and prepared by cooks of their own country.

Zone Government.—The department of civil administration embraces the affairs of government of the Canal Zone, the courts, the office of the prosecuting attorney, and the divisions of revenues, posts, customs, lands, administration of estates, police, education, fire protection, and public works.

Governor Magoon left the Isthmus Sept. 25, 1906, when the duties of his office devolved upon the executive secretary until Nov. 17. The Executive order of Nov. 17, 1906, created the department of law and government under the general counsel, after which date governmental matters were handled in Washington by the general counsel through the executive secretary on the Isthmus. On April 2, 1907, an Executive order vested the authority of the chief executive of the Zone in the chairman of the Commission, and by order of the latter the duties were assigned to one of the Commissioners.

Under authority conferred upon the President by existing law to legislate for the Zone, the five municipalities into which the Zone was divided were abolished and administrative districts were created in their stead. The United States patent, trade-mark, and copyright laws were extended to the Zone; provisions were made for regulating insurance companies, for the registration of land titles, and the celebration of marriages. By the order of March 13, 1907, the Commission is authorized to enact, with the approval of the Secretary of War, ordinances relating to police, sanitation and taxation, and matters formerly regulated by municipal ordinances.

The Mechanical Plant of the Boston Herald.

By Howard S. Knowlton.

In the production of a modern daily newspaper time is so valuable that the use of machinery has almost entirely replaced the slow hand methods of publication formerly in vogue. The appearance of an extra edition on the streets a few minutes in advance of a competitor scores a commercial advantage which is made possible only by a mechanical equipment which eliminates so far as possible every doubling back in the production processes between the desk of the writer and the counters where the papers are delivered. The mechanical plant of the Boston "Herald," in its lately completed buildings, affords an interesting illustration of the dependence of such a newspaper upon the engineer in its regular and special output.

The main offices of the "Herald" are in a five-story building at 171 Tremont street. At the rear of the office or "Administration Building" is the "Mechanical Building," a five-story structure connected with the former by a tunnel and an overhead passageway. The entire mechanical plant, including the production building, the power installation, sub-basement of the administration building, heating equipment, machinery foundations, matrix and newspaper carriers and other apparatus, was designed by Mr. F. W. Dean, of Boston, Mass., mill architect and engineer.

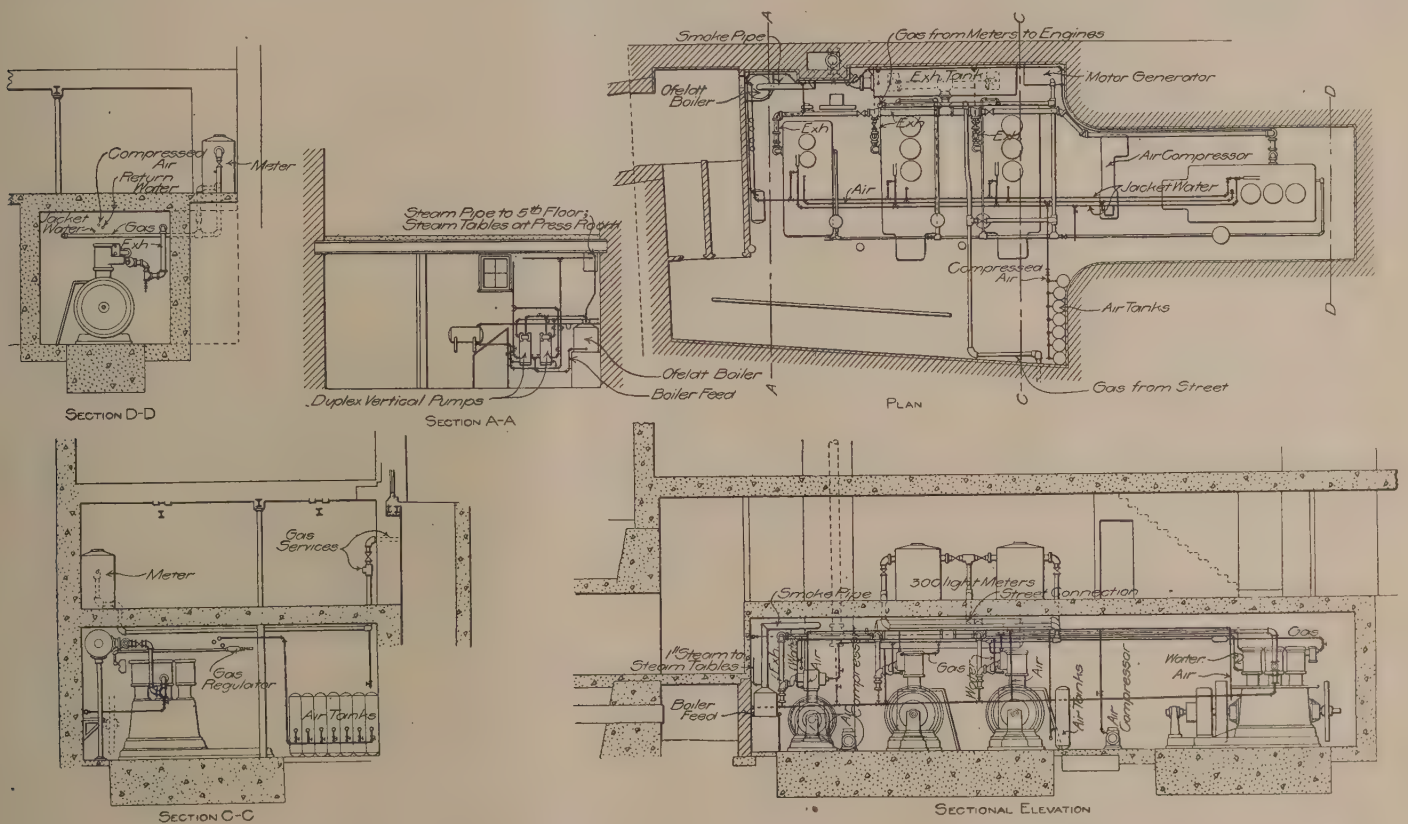
The Administration Building houses a power plant in its sub-basement, the basement being used for the storage of supplies and paper rolls. The office of the mechanical superintendent, Mr. G. S. Ross, is also located in the basement, and a small repair shop is installed under the Tremont street sidewalk. On the street floor are located the counting room and advertising department, and on the upper floors are bookkeeping, auditing, special writing, executive and editorial departments.

The Mechanical Building basement is given up to stereotyping, a press room, a locker room and lavatory. On the street floor are the newsboys' section, the mailing and job-printing departments. The next floor is occupied by the circulation manager, art, engraving and color departments, the next by city and news editors, the reporting staff, department editors and library. The top floor is utilized by the composing room.

To make clearer the relations of the mechanical plant to the production process a brief outline of the order of events in the turning out of an item in printed form is given here. An entire page of 8 columns metropolitan size, including all display, may contain less than half a column set by actual hand labor. Motor-driven machinery is found at every step. As soon as an item has been written by a reporter, it is delivered to the news editor and then carried by an automatic conveyor to the copy-cutter's desk in the composing room, where it is divided into sections which are parcelled out among the operators of the composing machines. From the machines the sections are collected and a proof struck and read; after this the type is corrected and automatically forwarded to the make-up table, where it is inserted in its place in a full page of type. As soon as the form is locked up, it is shifted to a table on wheels, and rolled to a steam table, where an impression of the form, called a matrix, is made on specially prepared paper. In the old days the form left the composing room to be matrixed in the stereotyping room, but in the "Herald" plant the matrix alone is sent down to the stereotyping room between two belts running over opposed sets of pulleys. The form and matrix are subjected to a steam pressure of 80 lb. for 3 or 3½ minutes, which partly removes the moisture. Enough tables are provided to press all the matrices which can be molded in that time. The matrix is then dried for 15 seconds in a rotary gas roaster, and transferred to the stereotyping room in the basement, where a stereotype casting is made from the matrix in a casting box. The plate is then trimmed and routed by electrically-driven cutting tools and locked on the press, from which issues the folded and counted papers. The latter are delivered by a motor-driven conveying equipment to the mailing and sales departments. The operation of the casting boxes and the steam tables, the making-up of the forms and their transfer from point to point are the only hand processes employed from the time the paragraph is given to the compositor until it is in the stereotype plate. A plate may be locked on the press in less than 8 minutes after the form it reproduces is completed.

The power plant in the sub-basement of the Administration Building consists of four Westinghouse gas engines, each direct-connected to 230-volt direct-current generators. There are three 85-h.-p. 11 x 12-in., three-cylinder vertical engines, each driving a 55-kw. dynamo at 300 r.p.m., and one 9 x 11-in., 35-h.-p., two-cylinder engine driving a 25-kw. generator at 310 r.p.m. These outfits deliver current on the three-wire scheme of connections and are provided with balancing transformers. Richardson cylinder lubricators are used. The engines burn gas supplied from the mains of the Boston Consolidated Gas Co., which has a calorific value of about 550 B.t.u. per cubic foot. For starting the engines seven vertical air tanks working at 170 lb. are provided, with a single-acting compressor, chain-driven, by a 3½ h.-p. motor. These tanks discharge into a 1½-in. main with 1-in. branches to each engine.

Two gas connections from the street mains are provided, each being a 4-in. line. These are joined inside the plants and carried in a 4-in. line to the middle of a connection between two 300-light meters on the floor above. One meter is used as a spare. From the meters a 4-in. line delivers to the gas engines through 2-in. and 1½-in. branches, a gas regulator being provided on the supply side of each engine. The meters are by-passed with locked valve control for emergency use. The stereotype and composing departments are supplied from an independent street connection through a 3-in. line, and risers distribute this supply to the various floors. The exhaust pipes of the engines vary in size from 3½ to 4 in. and are brought together in an 8-in. connection which leads into a muffler tank in the engine room. From this tank the exhaust is carried in an 8-in. pipe to an outlet over the roof about 115 ft. above the grade of the sub-



Arrangement of Gas Engines and Piping in the Mechanical Building of the Herald.

basement floor. Each exhaust pipe is separately valved.

The engine-room also contains a 22-h.-p. boiler which supplies steam to the stereotyping beds and the matrix heaters. Water is sprayed into the exhaust pipe of each engine and into the exhaust main for cooling purposes, this water being taken from the jacket outlet pipes through a ⅜-in. line. The jacket supply comes from the city mains through a 3-in. pipe into the sub-basement, and is delivered to the engines through branches averaging 1½ in. in size. The discharged circulating water from the jackets is pumped around the building for use in lavatories.

Special provision was made in the plant for ignition. Each engine is provided with three dry cells and also with two storage battery cells, which are charged through a resistance from the 230-volt circuit at the switchboard. There is also a Westinghouse motor-generator set for ignition, consisting of a 1¼-kw., 110-volt dynamo driven by a 2.2-h.-p. motor. The engine room contains a switchboard 20 ft. long consisting of eight panels, with recording wattmeters for each department, double-throw switches for each of the two sets of busbars installed on the rear of the board, ammeters, voltmeters and rheostats. Two of the panels are for generators, one is a totalizing panel with ammeter for the entire output, two are power panels, two are lighting panels, and one is a blank. Beside the general motor and lighting loads there are three electric elevators operated by the plant. Service is supplied to the manufacturing building through a reinforced concrete subway equipped with automatic sliding doors at each end.

The Herald buildings are heated by the steam heating plant of the Park Theatre through a 3½-in. underground pipe laid in a box of kyanized plank fastened together with copper nails. The pipe is covered with 85 per cent. magnesia, with a top dressing of Portland cement mortar. The various floors are heated by direct radiation. The returns from the steam heating system are carried back to the boilers through a 1-in. line.

The press room contains four Hoe sextuple presses and one Hoe color press. The floor is a terrazo pavement laid on 4 in. of Portland cement concrete. Each large Hoe press has direct connected to it a 50-h.-p. and a 4-h.-p. motor with Jenney control appliances. Five operations are provided on the push button boards which are located at several places on each press. The first starts the 4-h.-p. motor, turning the press at the slowest speed; the second button increases the speed and cuts in the 50-h.-p. motor, while the smaller motor automatically stops; the third button decreases the speed, the fourth is a bell signal button, and the fifth opens all circuits in emergency stopping. The starting boxes are motor-driven and automatically cut in resistance in case the power supply fails. The switches are mainly of the solenoid type, and seven-pole switches are provided to enable two presses to be run as one unit. The motors are installed in concrete pits below the floor, with trap door covers to enable them to be examined easily, and are compound wound to give the necessary starting torque. The total capacity of the plant is 375,000 eight-page papers an hour. The large double sextuple presses can each turn out a 96-page if necessary and can print one other color in addition to black. The color press is capable of printing seven colors at once, or black, and has a capacity of 75,000 eight-page papers per hour. The total capacity of the installation is 1,530 eight-page papers per hour per rated gas-engine horsepower in the generating plant.

Electric hoists are used in the press room to deliver the paper rolls to the presses, each roll weighing from 1,200 to 1,400 lb. and yielding from 9,000 to 11,000 papers. Rolls are brought into the press room from the storeroom by a traveling, hand-operated hoist, and a narrow-gauge track also connects the two rooms.

In the stereotype room the principal machine equipment is motor-driven. This includes a matrix roaster operated by a ½-h.-p. motor; three tail cutters, each driven by a 5-h.-p. motor; two curved shavers, each driven by a 2-h.-p. motor; one flat shaver, driven by a 3-h.-p. Lundell motor; a jig saw and drill run by a 1-h.-p. Sprague motor; a flat router driven by a 1½-h.-p. motor; a bending machine, operated by a 2-h.-p. motor; two curved routers, driven each by a 2-h.-p. motor; and a saw and beveler run by a 1-h.-p. motor. Sump-drained water is pumped to the sewer by a 3-h.-p. Knowles triplex pump driven by a General Electric motor.

The machine shop beneath one of the sidewalks contains a speed lathe back-geared to a ½-h.-p. motor; a circular saw driven by a 5-h.-p. motor; an engine lathe run by a 1-h.-p. motor, back-geared, and an emery grinder driven by a ½-h.-p. motor. All motors are 230-volt Jenney machines unless otherwise mentioned.

In the composing room are 27 linotype machines, each direct-driven by a ¼-h.-p., 110-volt motor, with two sets of fields on each pole piece. These outfits are gear-driven and can be run at 70, 72 or 74 r.p.m. Some of the machines are provided with eight different faces of type, and average setting 8,000 ems per hour, with a maximum of 9,000. They have about three times the capacity of the earlier linotypes, being equipped with interchangeable magazines of type matrices from 5½ point to 12 point. Ten seconds suffices to enable the operator to shift from one magazine to the other. The act of taking his seat on the part of the operator starts the corresponding linotype motor and throws the incandescent lamp over the keyboard into circuit.

The copy carrier in the composing room is driven by a ½-h.-p. motor, and three copy carriers serving the proofreaders' desks are each operated by a ½-h.-p. Holtzer-Cabot motor. There are two matrix rollers, each run by a 3-h.-p. motor. The matrix endless belt conveyor to the basement is driven by a 2-h.-p. motor; a small lathe for linotype work is run by a ⅓-h.-p. motor, and a metal saw by a 1-h.-p. motor. Cuts are handled between the basement and the upper floors by a push-button elevator which automatically stops at any predetermined floor.

The engraving room employs two 220-volt arc lamps in series, taking 8 amperes, for photographic reproductions. There are also two powdering machines and two etching machines, each driven by a 3-h.-p. motor. A saw and trimmer is run by a 2-h.-p. motor and two flat routing machines, making 20,000 r.p.m, are each operated by a 1¼-h.-p. motor. In the mailing room four conveyors are back-gear-driven by 2-h.-p. motors, and in the job printing room are two job presses run by a ¼ and a ⅓ h.-p. motor and a ⅓-h.-p. motor-driven addressing machine. In its use of direct connected motors on separate machines and gas-engine generators supplied from city mains the Boston Herald plant is of peculiar interest to persons watching the extension of power into the field of newspaper production. It is to be hoped that the economy of the plant will be published at some future time by those responsible for its installation and operation.

Independent Fire Protection for its yards and buildings at Pittsburg and Altoona has been secured by the Pennsylvania R. R. by equipping its switch engines in those yards with fire pumps and hose. A system of whistle signals indicates the location of the fire and the engine crews are trained in the use of their fire-fighting apparatus. At a recent fire nine engines were at the fire within seven minutes after the alarm.

Some Disputed Questions concerning Steel Rails.

A discussion of some of the disputed questions regarding steel rails was recently presented by Mr. Franklin E. Abbott, of the Lackawanna Steel Co., in a paper before the Central Railway Club. The first portion of this paper related to the general methods of making rails, from the ore to the finished product, and need not be reviewed here. The discussion of the controversial questions may be condensed as follows:

Composition.—Chemical analyses of average Bessemer rail steel as made at present for heavy rails run about as follows: Carbon, 0.50 per cent.; phosphorus, 0.10; sulphur, 0.08; silicon, 0.12; manganese, 1.00; iron, 98.20.

The quantity of carbon can be controlled by the grade of spiegel used. The makers and users of rails are not exactly agreed as to what the limits in carbon should be. When a 70-lb. rail was regarded as a heavy section, carbon ran from 0.35 to 0.40, but when the weights of rails reached 100 lb. per yard, 0.60 per cent. carbon was called for, and in some cases the upper limit was fixed at 0.65 per cent. The higher carbon steel, 0.55 to 0.65 per cent., was also specified for lighter rails such as 80-lb. and 85-lb. The 80-lb. rail was an increase in weight of only about 14 per cent. over the 70-lb., but 0.58 per cent. carbon often called for in this weight rail was an increase of fully 45 per cent. of this element over the lighter section.

The reason for raising the carbon was to get more elasticity and better wear, which in a degree was obtained, but with it came more failures from breakage. It was then specified that phosphorus should be lowered about 0.015 per cent., making the limit not to exceed 0.085 per cent. This proposition seemed entirely consistent from a metallurgical and theoretical standpoint, but practically it cannot be obtained because of the ore conditions.

It is estimated that the available 0.085 phosphorus Bessemer ores in the United States are relatively small. If all the rail mills in this country were to undertake to fill, from American ores, the annual requirement of about 3,000,000 tons under 0.085 phosphorus specifications for Bessemer rail steel, that grade ore would be exhausted before provisions could be made to meet the yearly demand for rails made by any other process.

If open hearth steel is to succeed Bessemer, it will take a term of years and the expenditure of an enormous sum of money to build furnaces enough to provide the steel needed for rails alone. Before this could be accomplished it is more than probable that the 0.085 phosphorus Bessemer ores would run out, and with an inadequate production of open hearth steel, the railroads would have to either get along with a short supply, or import the tonnage lacking.

To avoid this apparent short cut to the end of good quality Bessemer rail steel, the makers insist that the phosporous limit shall be left as it has been for a number of years past, at 0.10 per cent., and a somewhat modified carbon content be used. It is entirely practicable to use enough carbon with 0.10 per cent. phosphorous ores to make perfectly sound, safe and serviceable Bessemer steel, and with that limit accepted, the manufacturers will be able to produce good quality Bessemer steel rails for many years to come.

The wear of the heavier section rails has not been all that the users expected, even with the proportionally higher carbon, and they are loath to make any recession in this hardening element, fearing that by so doing, there will be still greater loss from rapid wear. But the question

of safety must have first consideration, and neither the makers nor users of rails will be justified in adding hardening properties, to get increased service, that will place the material anywhere near the danger line of breakage.

There is a strong probability, however, that harder steel may be used if the shape of the rails is changed. How this may be brought about will be considered further on.

The next element in order in the steel composition is sulphur. This is of little consequence to the user of rails. Its effect is to make hot steel "hot short" and liable to pull apart, making flaws on the surface of rolled shapes. A limit of 0.10 per cent. can be handled very well, but it is always to the interest of the manufacturer that it should be lower.

Silicon has a quieting influence in molten steel when it is settling and cooling in the molds and makes it dense when cold. A limit of 0.20 per cent. is generally stated in specifications.

The quantity of manganese in rail steel will run from 0.80 to 1.10 per cent. Its effect is to make the hot steel tougher, overcoming some of the bad effects of sulphur, and thereby better adapted to rolling. It also makes the steel harder and better for wear, but if the quantity exceeds very much the upper limit noted it is liable to lead to brittleness.

Discard.—Another clause in standard rail specifications that is a source of some contention between makers and buyers of rails, reads as follows: "Sufficient material shall be discarded from the top of the ingot to insure sound rails." Under that agreement the buyers of rails can get, and do get, perfectly sound steel. The interpretation of the term sound in this case means entirely free from piping or spongy metal. Sound steel rails of standard composition are perfectly safe to use, and when the railroad companies have exercised their rights given by the specifications in their inspection at the mills, while rails are being made, and thereby obtained sound rails, they have done their whole duty toward themselves and their patrons, whose safety and welfare they are bound to protect.

But the question arises why do the railroad people, or so many of them, come up with a demand for more discard, in some instances asking for a fixed amount not less than 25 per cent. of the whole ingot. It is not a question of safety, but one of service. Under present specification, the rail mills must deliver to the railroads safe rails, that is to say, free from the danger that comes from piping. They are obtained by shearing from the top of the ingot sufficient material to insure sound steel. Then what would the railroads gain by doubling the discard if 25 per cent. should amount to that increase? They might get a larger percentage of better wearing rails than they now receive, but the gain would be purely in an economical sense, and not in one of safety. Therefore, the question of more discard after enough has been made to insure sound and safe rails is purely a commercial one, and can be disposed of between the railroads and the steel companies without giving cause for any anxiety on part of the traveling public.

Drop Test.—In addition to the discard sheared off the bloom, a crop end is cut off the long rail when it is finished, taken from the end toward the top of the ingot. This is about 6 ft. long and is used for a drop test. One such test piece is taken from every blow of steel. It is placed on steel wedge-shaped bearings, 3 to 4 ft. apart, and struck with a 2,000-lb. weight, falling 15 ft. to 22 ft., depending on size of rail tested. If the test piece breaks under the drop, all rails from blow represented by that test must be discarded.

This is the most satisfactory proof of the quality and strength of the rails that can be used. If the steel is brittle, it will be discovered by the character of the break. If piped, that condition can be seen in the fracture and will determine at once whether or not sufficient discard has been made at the shears to insure sound steel. If the metal is very soft, it will show by excessive deflection. It can be seen, therefore, that the drop test throws out many safeguards against passing defective or inferior material.

Section.—Another difficult part in the making of steel rails is in the section. In the first place, it has to be very close to mathematically correct. A finished rail is a simple looking thing when it is made, but there are a good many dimensions besides the length to take into account in getting it through the mill in proper shape. The ordinary rail section is made up of 17 separate and distinct dimensions, 9 of which are duplicated, making a total of 26 to be kept in order and held in their respective places when the rolling is under way.

The section is continually checked during the process of rolling. This is done by a steel template made to exact dimensions of one-half the rail divided by its vertical axes. The rail section is tested on both sides by the same template, and therefore each half is as nearly like the other as possible to make it. In checking rail sections, the inspector has to guard against either over or under size and always strives to maintain perfect symmetry. In this detail, a difference of 1-64-in. cannot be ignored and the wonder is how such ponderous and coarse machinery as constitutes a rolling mill can be so nicely adjusted as to accomplish such fine results. It is not easily done, and it should be remembered that the turning or shaping of rolls and the manipulation of steel through them when rolling is under way, is the most intricate part of the rail-making process.

One of the leading advantages to the manufacturer in the Am. Soc. C. E. sections is in the distribution of metal in its different members. In the head there is 42 per cent.; in the web, 21 per cent., and in the base, 37 per cent. There is but five points difference between head and base, and these are so much closer than many of the sections the mills were formerly required to make that they gave the Am. Soc. C. E. sections a cordial welcome and have always tried to further their use.

At the time these patterns were introduced an 80-lb. rail was regarded as a heavy section, and some engineers even doubted whether one so heavy could be used economically. The designers, however, evidently expected railroad track to grow, for they provided for 5 lb. per yard increase in weight till 100 lb. was reached, and then designed a 110-lb. pattern, apparently for a good measure.

Shrinkage.—The period during which the 80-lb. rail was regarded as heavy was not of long duration, for the railroad soon took on 85-lb. and 90-lb. sections and during the past few years a very considerable tonnage of 100-lb. rails have been made. The 90-lb. rail was an increase of about 12½ per cent. and the 100-lb. about 25 per cent. over the 80-lb. The users of rails naturally looked for a proportionate gain in wear for the additional steel bought. But this did not always obtain and led to the criticism that they were not properly worked; that they were rolled too fast and finished too hot. An effort was then made to incorporate in standard specifications what was called a "shrinkage clause." By this is meant that the rails when they reach the hot saw shall be at such reduced temperature that only a certain number of inches and fractions of an inch shall be allowed for the rail to contract in length from the temperature at the sawing down to 70. It was expected that if the mills could comply with this, the steel would come through the finishing passes at a lower temperature, and the colder rolled steel would give better wear.

It would be perfectly reasonable to look for those results from such conditions. But the difficulty of incorporating a shrinkage clause in general specifications and making it operative was found in the fact that rails cannot be brought to the hot saws at the same temperature in every mill. There are no two in which the shrinkage could be kept exactly alike, therefore, any fixed allowance in a general specification could not be made applicable in all places. The opposition to a definite shrinkage clause in specifications is raised on account of the insurmountable difficulties encountered in attempting to fix a temperature at which the finishing work shall be done in unbalanced sections.

As already stated, the Am. Soc. C. E. section, or any other tee-rail thus far made, has greater percentage of metal in the head than in the base. The head is in a mass with less radiating surface than the base. The base is not only smaller, but thinner, besides having a greater radiating surface. It can, therefore, be readily understood why there is considerable difference in temperature between head and base, when the rail goes through the finishing passes. The object of a shrinkage clause was to improve the rail head by finishing at a lower temperature, but in an unbalanced section the base is likely to get too cold to work, or so hard as to cause damage of cracking the rolls, while the head may still be hot enough to admit of some reductions.

Cambering.—Cambering of the rails is made necessary to counteract the warping that takes place in cooling. The warping is due mainly to the shape of the section, and the rail is rarely perfectly straight when cold. Whatever warp or crook that may be left in must be taken out by cold straightening. This is done in a press under a slow-motion plunger by applying pressure on the rail centrally between bearings for 42 in. apart. The arrangement of this press has lately become part of a general specification, and for that reason should receive some notice in this connection.

It is pretty generally conceded by both rail makers and users that the strain and torture that rails have to endure in cold straightening are the most severe and most objectionable work in the whole manufacturing and finishing process. The impossibility of taking a bend or kink out of a rail without straining it beyond its sectional elastic limit makes the necessity of setting up internal stresses, working at cross purposes with the normally cold tension of the steel, unavoidable. To what extent these may be harmful to the rail after it is put into service cannot be definitely determined, but it is only reasonable to infer that they have some effect. The remaining work in finishing after the straightening is done consists of drilling, chipping, filing, etc., all simple mechanical or hand operations not likely to cause any injury.

Rail Usage.—It is not an uncommon occurrence for a panel of rails in first-class track to carry a load upward of 200 tons over its entire length in half a second of time or less. This enormous weight coming onto the rails in such a short interval causes a shock almost equal to a hammer blow. During this short space of time every foot of the rail throughout its entire section is subjected to alternating tension, compression and torsion and the head to crushing and abrasion. There is not a piece of steel made for any structure whatever that has to withstand such severe treatment as that imposed on a rail.

The users contend that rails fail because of defective material or shortcomings on the part of the manufacturers in the process of making. The manufacturers claim that the users do not specify the grade of steel, nor weight of rail

best suited to their various traffic and climatic conditions; that maintenance of way is not always what it should be; that bad order rolling stock and irregular operations of motive power are responsible for a greater part of rail destruction.

There are nine or ten classifications of rail failures, but more than 95 per cent. can be placed under less than half that number. The remainder are of rare occurrence and little account.

Piping.—First are the head failures which are the result of piping, or caused by the metal actually shearing off at the sides, usually about on line with one side of the web. Piping is a defect adherent in the steel, and the whole responsibility for this rests with the manufacturing. Every practicable precaution is constantly exercised against such material going into rails, but in spite of all that can be done, some with this defect get into use.

To reconcile the fact that piped rails are found, with the claim made that sufficient material is discarded from top of ingot to insure sound steel, it will be necessary to explain that piping in ingots is not confined entirely to the top, but does at times occur all the way down through the center, although it may not be continuous. Such piping will not show at the ends nor give any surface indication of its existence when rails are finished. It ordinarily develops under traffic and then appears by the head flattening or spreading out. Only a very small percentage of piped rails give out suddenly, or without first showing this condition on the head surface and affording time for removal before harm is done. Some railroad engineers say that they do not regard rails showing slight piping as particularly dangerous, and often allow them to remain in use after their condition is known. It is the opinion of the writer, however, that rails which show piping in any degree are wholly unfit for any main line track, and never should be allowed to remain in service.

Split and Crushed Heads.—Split head failures occur mainly on high curvature track and on the inside or low rail of the curves. These are apparently due to irregular bearings of worn wheels and cross strains thrust into the rail head by tread of false flanges, on extreme outside corner. This leverage brings the maximum stress at top of rail heads, about on line with side of web, where such breaks are generally found.

Another type of failures resulting from rail and track conditions, similar to that just mentioned, is in the metal flowing or crushing off the corners of the head. The inside wheel of a train passing around a curve, not only rolls but slips over the rail, and when the track gauge is wide, it slides across the head, causing the metal to flow or shell off in long, ragged strips. This kind of giving out is sharply criticised and often causes considerably anxiety among railroad engineers, on account of the seeming weakness. Such rails have an extremely bad appearance and ordinarily show excessive wear, but they are not unsafe to run over and may be retained in service without any unusual risk, until completely worn out.

Breakage.—By far the greatest number of failed rails are due to breakage, that is to say, complete fracture of the entire section. These are not only most numerous, but most dangerous of any in the whole classification. There are three distinctive characters—breaks that may be described and in a measure accounted for as follows:

First: The square break in which the fracture is almost at right angle with the axes of the rail and is often quite as regular as a saw cut. The fractured surface may be fine, close, homogeneous texture, but the shape of the break indicates excessive hardening properties in the metal, bringing it close to the point of brittleness, hence, easily ruptured by shock and therefore poor quality steel for rails.

Second: The angular, or shearing break, which generally passes through the section at an angle of 45 deg. or less, with longitudinal axes. This shows that the rail stood a deflection and elongated before breaking, indicating ductility and a perfectly good grade of steel, but probably broken by severe shock or excessive overloading.

Third: The base break. There are more failed rails from breaks of this character than from any other cause. It is found in varying degrees on all railroads and in rails from all mills. The principal peculiarity of this break is that it starts at the center of the rail base, directly under the web, and develops longitudinally, extending from 6 in. to 18 in. and will then run out to the edge of the flange, resulting in a "half moon," or flange break, and in many cases also extending upward through the rail, causing a complete fracture of the entire section.

As a girder the rail seems to be theoretically and practically correct in shape. But it has always been shown that the roadbed and ties, which constitute the rail foundation, are unstable, and yielding and that the solidity of tie bearings are at times widely variable, making the bearing surface of the whole rail base quite irregular and uneven. These conditions are generally worse when the roadbed is frozen. In consequence, the base member of the rail section has to sustain excessive compressive strains at the higher or more solid points of its bearings.

The rail base in compression will, on account of its shape, buckle, drawing the edges of the flanges upward, thereby causing a cross strain with maximum tension at the center directly under the web, and this is the point where base break begins. Therefore, it appears that the base member of the girder tee-rail as now made is deficient when subjected to compressive strain and for that reason fails.

Improvements.—Just at the present time we seem to have reached one of the transition periods in the manufacture and use of steel rails, in which the rails as made do not quite balance with the railroad traffic as it exists. A correction must be found.

The manufacturer is held by certain limitations in character of raw materials that prevent meeting all that might be desirable in changes of composition of steel for the improvements needed. The railroads cannot recede in the matter of heavy loads and fast trains, and must by some means get rails that will hold up to changed conditions as they are.

It is believed that a remedy can be obtained by the co-operation of the manufacturers and railroads in bringing out a revised rail section. This will embody certain cardinal principles and be designed with a view to overcoming detail deficiencies found in the present sections, at the same time be a better shape to roll. It is suggested that, in comparison with the Am. Soc. C. E. sections, both head and base shall be reenforced, and that the distribution of metal be nearly balanced, making that in the base equal or slightly greater than in the head. It is also proposed that width of base shall be less than height of rail, which will admit of forming thicker flanges.

The advantages of a balanced section, with comparatively thick base are:

First, lower temperature of the whole section at the final pass, hence a colder finish of the rail head, giving denser and better wearing material.

Second, less cambering and better hot straightening, reducing as much as possible the objectionable cold straightening work.

Third, a reinforced head to provide against splits and other head failures.

Fourth, a reinforced base to overcome the weakness that seems so prominent in present pattern rails.

It is expected, also, that with this pattern rail the higher carbon steel from grades of ores now available may be made with safety, and by longer service prove a benefit to the railroads. The balanced sections can be made easily and economically, and will thereby contribute to the interests of the manufacturer.

Traveling Derrick for Trenching for 15-Foot Sewer, Borough of Queens.

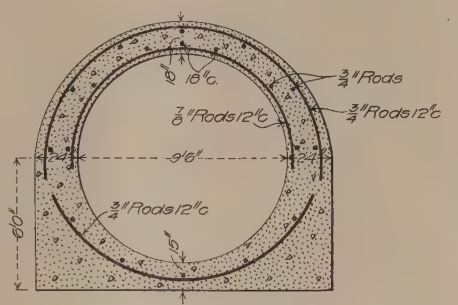
A Steel Stack over 100 ft. high and weighing 22 tons was erected recently in a single piece at the works of Messrs. Brown, Bayley & Co., Sheffield, England. The stack is 10 ft. in diameter at the base and 7 ft. at the top and serves a 20-ton open-hearth furnace. It has no stays or braces but the brick base is founded 20 ft. below ground, and the iron base plate is anchored to the brickwork by eight 16-ft. bolts. The stack was raised in slings by a high derrick and the base was then guided into the flanged base plate to which it is securely bolted.

A Large Reinforced Concrete Sewer in the Borough of Queens, New York City.

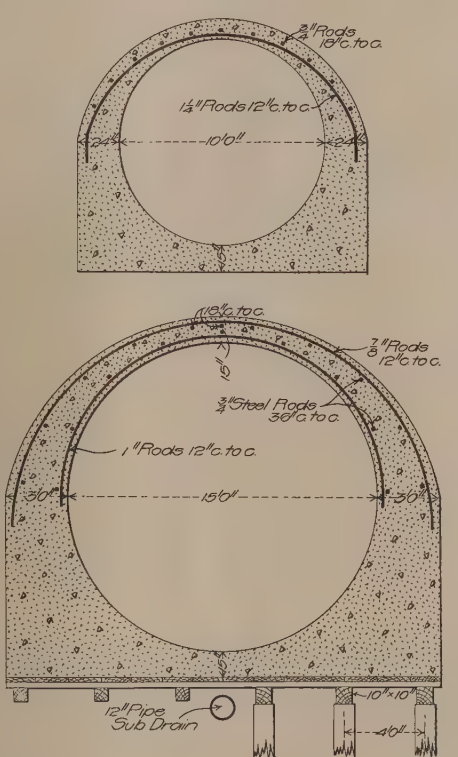
A circular reinforced concrete trunk sewer, varying from 2½ to 15 ft. in diameter, is now being built in Myrtle and St. Nicholas avenues, in the Borough of Queens, New York City, to serve a 2,150-acre area in the southwestern section of that borough. This work is part of a general sewerage system planned for the southwestern part of the Borough of Queens. This borough, while the largest of the five that make up Greater New York City, covering an area of 127 square miles, is, at the same time, the most sparsely populated, having less than 250,000 inhabitants, collected in scattering settlements. The water front totals 116 miles, but the length along which sewage may be discharged is limited to 27 miles by laws prohibiting the discharge of crude sewage into Flushing and Jamaica bays and Newtown creek. This complicates and makes difficult the problem of sewerage, and in the case of the system mentioned necessitates carrying the flow to the East River, through a 16-ft. continuation in the Borough of Brooklyn. The work in Brooklyn has not yet been put under construction.

The approximate quantities of work included in this contract in Queens are: 1,355 ft. of 15-ft. sewer; 690 ft. of 11¼-ft.; 1,335 ft. of 10-ft.; 2,070 ft. of 9½-ft.; 2,000 ft. of 5 and 5½ ft., and 2,190 ft. of smaller sizes. The total length under contract, including 255 ft. of 24-in. pipe sewer, is 9,845 ft., and the total fall is 46.73 ft. The grades are: 0.002315 in the 15-ft. section; 0.00296 in the 11¼-ft. section; 0.00442 and 0.00412 in the 10-ft. and 9½-ft. sections; and 0.0052 to 0.00425 in the smaller sections. The cover over the larger sections is fairly uniform, being in general about 15 ft. At one point, however, the cover over the 9½-ft. sewer is 22 ft. deep. The smaller sizes, from 5½ ft. down, have, in general, 8 to 10 ft. of cover. The excavation is mainly in sand or sandy soil, and practically no water has been encountered.

The sewer now under construction in the Borough of Queens has the same general sectional form in all sizes, the outer sides of the invert being tangent to the extrados of the arch at its springing line and carried down vertically to meet the plane of the foundation. The concrete below the springing line is a 1:2:4 mixture of Atlas Portland cement, sand and bank gravel, having a maximum size of 1½ in., and is without reinforcement. Above the springing line all sizes are reinforced laterally and longitudinally with "new style" Johnson corrugated bars. The concrete of the arch is the same as that below the springing line, except that the stones larger than ¾ in. are screened out. The sections of sewer smaller than 4½ ft. in diameter have ¾-in. lateral rods, 12 in. on centers, and three lines of ¾-in. longitudinal rods over the crown and haunches; the arch in all these sections is 6 in. thick at the crown and 6 to 9 in. thick at the springing line; and the lateral rods are equidistant at all points from the intrados of the arch. The sizes from 4½ to 5½ ft. in diameter, inclusive, have ¾-in. lateral rods, 12 in. on centers, and ¾-in. longitudinal rods, 18 in. on centers, but the lateral rods are placed on a three-centered curve, being near the intrados at the crown and near the extrados at the springing line. The longitudinal rods rest directly on the lateral rods. The arch ring in these sections varies from 6 to 8 in. thick at the crown and from 12 to 15 in. thick at the springing line. The 9½ and 10 ft. sections are much like those just described. The lateral reinforcement is three-centered, and the thickness at the crown and springing line is 12 and 24 in., respectively, for both sizes. The 10-ft. section is shown in the accompanying illustration. The 11¼ and 15 ft. sizes have two series of both lateral and longitudinal rods, one series being parallel to the intrados and the other parallel to the extrados of the arch ring, as shown in an accompanying illustration of the 15-ft. section, on which the important dimensions are indicated. The arch ring of the 11¼-ft. section is 12 and 27 in. thick at the crown and springing line respectively, and the reinforcement is like that of the 15-ft. section, except that the outside lateral rods are ¾ in. instead of ⅞ in.



Section under Tracks.



Sections of Large Sewer, Borough of Queens.

In designing the larger sizes it was assumed that the covering material, which is in many places clean sand, would, when saturated with water, transmit live loads very readily, and the sections are accordingly liberal. Moreover, the magnitude and permanency of the work warranted no doubtful economy of material, and the minimum thickness of protective covering of concrete over the reinforcing rod is accordingly in general about 2½ in. Pile foundations of the form indicated in the illustration are specified, to be used where required, but the excavation so far has been in good, dry, sandy soil, and no piles have been necessary.

The tracks of the Long Island R. R. cross the sewer over the 9½-ft. section, necessitating extra heavy construction for a distance of about 70 ft. Here the thickness of the arch ring at the crown and springing line is increased to 18 and 24 in., respectively, and the ring is reinforced with two series of lateral and longitudinal rods, one parallel to the extrados and the other parallel to the intrados, as shown in an accompanying illustration. A third series of lateral and longitudinal rods placed parallel to the surface of the invert reinforces the section below the springing line.

Along the line of the main sewer several junctions with tributary sewers are required. Of these, the one at Myrtle and Cyress avenues, where a 7-ft. sewer enters the 11¼-ft. section, is typical, and illustrations of it are given. The drawings of this intersection also show a reducer from 11¼ to 10 ft. just above the junction point.

Manholes are provided throughout the length of the sewer at intervals which do not in general exceed 250 ft. On the sections larger than 5 ft. the manholes will be placed at one side of the axis of the sewer, so that the vertical axis of the manholes will be about tangent to the barrel of the sewer. Center manholes on sewers as large as these make it difficult and dangerous for workmen to enter the sewers. The arrangement adopted will in a great measure remove this difficulty. The bottom of the manhole is usually at or a little below the springing line of the arch, and steps are provided leading down the side of the invert to the bottom. Up to a point about level with the crown of the arch ring the manhole is built of concrete reinforced with ¾-in. rods, which are bent into the arch ring wherever possible, as indicated in an accompanying illustration. Above the concrete the manhole is carried up to the cast-iron cover with brick work in the usual manner. A double-track street car line, which traverses the part of Myrtle avenue occupied by a section of the sewer 10 ft. and less in diameter, has influenced the position of the manholes somewhat, but they are placed either between the rails or outside the tracks, as the case requires.

The sections of the sewer 5½ ft. or less in diameter are built without the use of much mechanical equipment. Two-inch hemlock planks, 6 to 8 in. wide, are carefully driven to serve as sheeting and as boxing for the vertical walls below the springing line. The excavation is carried on with pick and shovel, the spoil being hoisted and delivered along one side of the trench in small buckets by a portable horse-power derrick mounted on a heavy four-wheel truck. The street car track, which is operated as a single track line where the work is in progress, is shifted over to the side of the trench not occupied by the spoil bank, and it has been possible to maintain the operation of cars constantly. Sand, cement and gravel are stored in convenient piles in vacant lots beyond the street car track and are delivered to the work in wheelbarrows. The concrete is hand mixed on a plank platform spanning the trench.

In building the smaller sections a slab of concrete is first laid on the bottom of the trench, its top surface being kept a little below the grade line of the finished invert. A narrow strip along the center of the top of this slab is then built up carefully to the grade line, and the cradle forms are rested on it, being braced from the sides with wooden struts against the sheeting, and internally with rods and struts supplied with turnbuckles and screws. The concrete is then poured up to the level of the springing line. Before it has set the ends of the lateral rods of the arch ring are thrust into it at the proper point, the weight of the rods being carried by a ridge pole previously fixed at the proper height. The placing of the concrete of the arch ring is carried on in the usual manner. Sheet-steel forms, made by the Blaw Collapsible Steel Centering Co., are used for all sizes of the sewer.

On the larger sizes of the sewer the excavation is also carried on by pick and shovel, but more elaborate equipment is required to hoist the spoil and deliver it as back-fill. In Myrtle avenue, near its intersection with Cypress avenue, the section of 10-ft. sewer is now being built; here the cover

is about 14 ft. The sides of the trench are retained, as in the smaller sizes of sewer, with narrow 2-in. hemlock sheeting, driven by hand in 16-ft. lengths and carefully supported by waling pieces and struts. Here again the sheeting serves as boxing for the vertical outside walls of the invert.

The spoil is shoveled into 1-yd. Haywood buckets, which are hoisted by two stiff-leg derricks, with 25-ft. booms, and masts short enough to clear the overhead trolley construction above the street. These derricks, with their hoisting engines and boilers, made by National Hoisting Engine Co., are mounted on a large platform traveler, which spans the trench, with three wheels on each side running on heavy railroad rails. These rails are laid on 6 x 8-in. timbers, laid across the trench about 3 ft. on centers and extending far enough beyond the sheeting to secure a good bearing.

The derrick mounted on the front end of the traveler handles the top surplus spoil not required for back-filling. This material is delivered to Troy dump wagons and hauled away, to be used in filling neighboring lowlands. The derrick on the rear end of the traveler handles the back-filling material, which is delivered to 1-yd. Koppel cars, operated by hand on track laid on the 6 x 8-in. timbers spanning the trench, which have been before referred to. These timbers are left in place behind, as the traveler proceeds, to carry the narrow-gauge track and are taken up as the back-filling progresses.

At Cypress avenue a street car line crosses Myrtle avenue, and when the traveler was on one side and the unfilled trench on the other side of this car line it was necessary to run the dump cars across it. This was accomplished by means of a turn-table of heavy bar-iron rails, arranged so that when a street car passed the turn-table could be turned, with its axis parallel to the car track, so that the turn-table rails would clear the car wheels. The car track was supported over the trench by lines of timber stringers.

The order of procedure in constructing the larger sizes of the sewer is much the same as has been described for the smaller sizes. The bottom slab is laid first and brought up to the grade line of the invert along its center, to carry the cradle forms, which are braced both from the sides of the trench and internally, as shown in the accompanying illustration. Before the placing of concrete is begun the cradle and arch forms are carefully trued up under the direction of an inspector. Wooden pegs are inserted in the key-holes at the free end of the steel forms, to hold the wooden bulkhead in place. The turn-buckles and screws are covered with cloth or paper to prevent their becoming fouled with concrete.

The concrete for the 10-ft. section is mixed in a 1-yd. Smith machine, mounted on a low truck, which is moved alongside the trench as the work progresses. The mixer delivers through a short chute into a small hopper, which rests on horizontal timbers, laid parallel to the axis of the sewer on the series of transverse sheeting struts second from the surface of the ground. From the bottom of this hopper a 10-in. sheet-iron pipe leads down to a point a few feet above the crown of the arch ring. Here open chutes are provided, which lead the concrete to one side or the other, as required. The concrete is mixed wet and exerts a heavy pressure on the forms, which have to be braced very securely. In the larger sizes of the sewer the curved lateral rods are not put in place until the arch ring is about to be constructed. To provide for their support, holes are formed in the top of the sides of the invert while the concrete is still green, into which the rods are securely grouted later.

The lateral rods are bent at very little expense on the work by unskilled laborers. For this work a heavy plank platform is provided on which are nailed sticks 3 or 4 in. square and about 2 ft. long, placed radially so that their outer ends around which the bars are bent form a horseshoe-shaped curve. This curve, which is, of course, quite different from the curve of permanent set which the rods take, had to be determined by experiment. A separate series of blocks is necessary for each size of sewer but two or three curves can be formed on one platform by imposing one series of blocks upon another.

In St. Nicholas avenue, where the 15-ft. section is under construction, the same general methods of excavation and placing of concrete have been used as have already been described. Here, however, only one derrick is mounted on the traveler platform. It is of the stiff-leg type and is operated by a National hoisting outfit. The boom is 35 ft. long. A blacksmith's equipment is carried on the traveler platform where picks are sharpened and repair work is done with minimum delay.

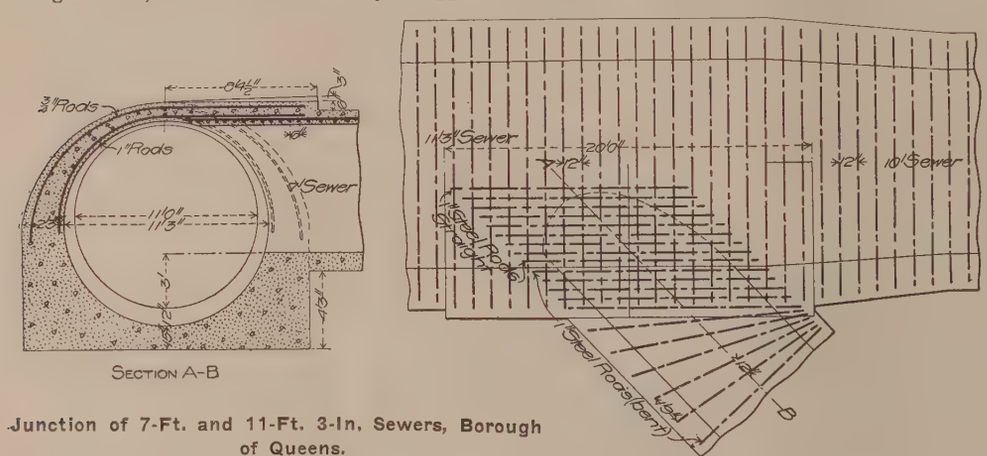
A large part of the excavated material in St. Nicholas avenue is sand, which is available as concrete material. This is stored in convenient piles along the work and as the storage space was limited, the piles are high. In order to maintain the operation of the dump cars from the derrick to the storage piles by hand the track is raised on timber cribs placed about 20 ft. on centers between which are lines of timber stringers on which the Koppel track rests directly.

The double-track elevated steel structure of the Ridgewood division of the Brooklyn Rapid Transit R. R. crosses St. Nicholas avenue with too little clearance to allow the passage of the traveler and derrick. When the excavation reached the east line of the railroad structure, the derrick was dismantled, the traveler moved to the west side of the railroad track, and the derrick mounted again. Two short lines of narrow gauge track were then laid within the limits of the trench excavation under the steel structure parallel to the axis of the sewer. The dump bodies of two of the regular Koppel cars were then taken off and low wooden platforms substituted. One car was placed on each line of track with a Hayward 1-yd. bucket on its platform. As the buckets were filled by the shovellers, the cars were run forward to the west side of the elevated structure where the derrick could reach them. The tracks were lowered as the excavation progressed and when the portion of the trench under the elevated railroad was finished both cars and track were hoisted out by the derrick.

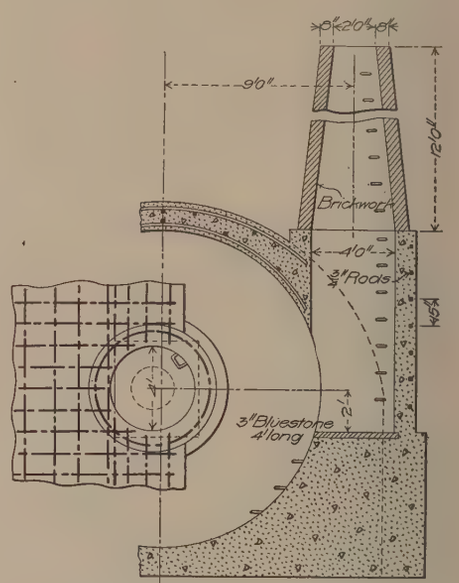
The four steel columns of the elevated structure in St. Nicholas avenue are placed two on each side of the pavement, just outside the curb lines. As the footings of these columns are close to the trench it was thought to be dangerous to depend on the trench sheeting to sustain the lateral pressure due to passing trains. Accordingly, part of the weight carried by the columns has been transferred to four timber towers, each made up of four 10 x 10-in. timbers, placed under the girders close to the property lines and wedged up to a solid bearing.

When a section of forms is to be drawn forward into its new position the traveler platform is anchored in place and the hoisting engine is utilized. The forms are oiled carefully before each new section of concreting is begun and no difficulty has been experienced in drawing them. The invert and arch surfaces secured are very smooth and require no plastering or patching. The forms for the arch ring and invert of the 15-ft. sewer are handled in 30-ft. lengths. The hoisting equipment and traveler is moved forward with its own power by means of tackle attached to any convenient anchorage.

The work is being prosecuted under the direction of Mr. Joseph H. De Bragga, superintendent of sewers, and Mr. J. H. Johnson, chief engineer. The plans and specifications were prepared by Mr. Alberto F. Schreiner, assistant engineer, and Mr. Elmer W. Firth, assistant engineer, is in immediate charge of construction. The Sigretto & Manino Co., Brooklyn, N. Y., is doing the work, the total cost of which is $393,743.75. A surety bond of $155,000 was required and 400 working days are allowed for the completion of the work. The progress made so far indicates that the work will be completed within the specified time.



Junction of 7-Ft. and 11-Ft. 3-In. Sewers, Borough of Queens.



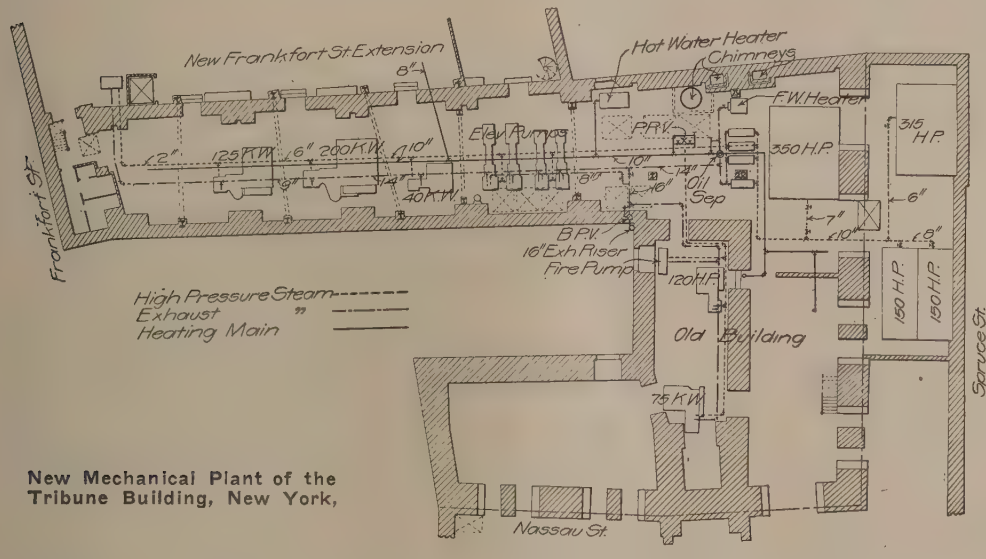
Special Manhole for Large Sewer.

Longer Drill Rods than an ordinary air drill tripod will take were used recently by suspending the cylinder between the guides of a small pile driver frame.

New Mechanical Equipment of the Enlarged Tribune Building, New York.

The ten-story building of the New York "Tribune," at Nassau and Spruce Sts., New York, has recently been raised and remodeled into a twenty-story office structure and increased in floor plan by a 60x116-ft. extension of similar height. The interesting and unusual engineering problems involved in this reconstruction were described in The Engineering Record of June 1. With the reconstruction of the building, extensive additions to the power and mechanical plants became necessary and as the equipments of the original building were entirely incapable of extension to the capacity desired, an entirely new layout was designed, providing the increased capacity required and ample accommodation for future growth. The power plant had consisted of an equipment of four small boiler units and of both Corliss and high speed automatic engines for the operation of the printing presses and dynamos, while the heating system was designed for operation with high pressure steam, a usage now practically extinct. The original elevators were of an early Crane design and incapable of extension. After a study of the requirements of the building as extended, it was decided to abandon the greater part of the original mechanical equipment and replace it by new equipment of modern design, which should be accessibly located and have sufficient reserve capacity for emergency requirements. While the new plant and its equipment involves many features of interest, its installation is of peculiar interest for the reason that the equipment is installed largely in the basement space occupied by the original apparatus, all of which it was necessary to keep in operation until the new apparatus had been placed in running order. Owing both to greatly congested space in the basement and to the necessity of entire rearrangement of the plant, the work was attended throughout by many temporary arrangements and connections, which hampered the work a large part of the time, but the new installation was finally completed without accident or interruption of any of the building services.

The basement space allotted to the power plant in the original structure consisted of a 16x40-ft. passage under the front portion of the building and the 24x170-ft. space under the rear portion, extending through between Spruce and Frankfort streets, with, in addition, the 18x63-ft. space under the Spruce street sidewalk, in which the boilers were located. In the remainder of the space under the front portion of the building were located the printing presses, pressroom and other portions of the Tribune's printing plant, with the exception of the stereotyping department, which shared with the power plant the basement space in the rear extension. With the extension of the Frankfort street frontage, however, a greatly increased basement space was there afforded for an enlarged printing plant, and also a division of that space was devoted to the requirements of the stereotyping plant, thus entirely freeing the central basement space for the power plant equipment. The rearrangement of the power plant consisted in the main of remodeling the boiler plant, the removal of the engines and the electrical generating equipment from the front portion of the Frankfort street end to the original basement in space formerly occupied by the stereotyping department, and the location of the new elevator equipment in the central portion of this section, next to the boiler plant. In the latter there was also added later a fourth unit of 350 h.p. capacity, just within the building wall from the original boilers. The plant has always been limited as to space available for fuel storage, and no increase in storage is as yet available from the new arrangement, although when the presses and the printing plant are moved from their present location in the front portion of the basement to the new basement space under the Frankfort street extension a large amount of space will become available under the front portion of the building for coal storage, additional mechanical equipment and rearrangement of the boiler plant if need be. Access is had to the basement for machinery parts and supplies by conveniently located sidewalk lifts on both the Spruce and Frankfort street fronts.



New Mechanical Plant of the Tribune Building, New York.

The steam generating equipment had originally consisted of two 60-h.p. horizontal return tubular and two 150-h.p. Babcock & Wilcox water tube boilers, which were located in the Spruce street sidewalk vault, but early in the course of reconstruction the return tubular boilers had been replaced by a single Babcock & Wilcox water tube boiler of 315 h.p. rating, to provide needed additional capacity. As the other water tube units were of comparatively recent installation they were retained for the new plant and merely supplemented by a new unit of the same type and make, which is of 350 h.p. capacity, giving thus a total steam generating capacity of approximately 1,000 boiler h.p. This capacity will enable the maximum power demands of the enlarged building to be carried with one unit always in reserve. The new unit was installed alongside of the 315-h.p. boiler, just within the building wall, so that the same firing floor serves all four of the boiler units and also a considerable space is afforded between these units for the storage of fuel. The only other change in the boiler plant was the erection of a steel smoke stack to supplement the two 24x36-in. flues in the rear wall, which served the four original boilers; the new stack is a 48-in. cylindrical steel stack, rising through the building in a 5x8-ft. shaft enclosure to a point some 260 ft. above the grates, and is connected by a breeching on the basement ceiling to the two larger boiler units, while the two 150-h.p. boilers are served by the wall flues through the original underground flue connections.

The boilers are of the standard Babcock & Wilcox inclined tube construction, designed for 125 lb. working pressure, the two larger units being arranged in single settings and the smaller units together in one setting, as shown in the basement plan of the building. The largest unit is of the longitudinal drum type, having three 36-in. drums and 189 4-in. tubes, 16 ft. in length, giving a total heating surface of 3,527 sq. ft., and has a furnace of 88 sq. ft. grate area. The other boilers are all of the cross-drum type, the larger unit having 144 4-in. tubes, 18 ft. in length, giving 3,100 sq. ft. of heating surface, while the two small units have each 84 4-in. tubes, 18 ft. long, with 1,500 sq. ft. of heating surface each. The two larger units are fitted with Thompson dumping grates for burning low grade anthracite coal and are hand fired, coal being dumped directly from wagons in the street into the storage space or on to the firing floor. Ashes are removed in the usual way, in cans upon the adjoining sidewalk lift. The boilers are fed by two 9½x5½x12-in. feed pumps in duplicate, one a Knowles type A simplex pump, which was used in the old plant, and the other a new Davidson pump, either one of which is of capacity sufficient to operate the entire boiler plant. The pumps draw from a Webster open feed heater of 1,000 h.p. capacity, which has been installed at the rear of the boiler room for heating the feed by exhaust steam, and delivers to the boilers through a 2½-in. main, with 2½-in. and 2-in. branches to each unit. The greater part of the feed water supply is condensation returns from the heating system and other steam apparatus, with make-up from the city water supply, all of which is filtered through a building service filter equipment installed by the New York Continental Jewel Filtration Co. The boiler blow-off system consists of a 3-in. main with 2½-in. blow-off connections to each boiler, which delivers the discharge into a blow-off tank under the firing floor for partial cooling, from which it is subsequently raised to the sewers in the adjoining street by a small steam pump.

Owing to the general rearrangement of apparatus, practically all of the piping of the plant had to be reconstructed and enlarged, and as, on account of the importance of the service, all new work had to be erected and placed in service before any of the original piping could be dismantled, all systems were laid out on as simple an arrangement as could be devised. The high pressure steam system consists of a single 10-in. main leading from the boiler room directly to the engine room, with an 8-in. branch into the old section of the plant in the front portion of the building. It has double-valved supply connections to each of the boilers, which are graded to drain condensation into the mains, while the latter has all steam delivery connections made from the upper side, so that condensation will accumulate in the main; this condensation is removed from the main by connections to the feed and vacuum pumps, which are connected from the lower side, and by steam traps at the ends of the main run and of the branch. In the 8-in. branch to the old division of the power plant connection is made with a low branch from one of the 150-h.p. boilers, which serves as a by-pass to the 75-h.p. generating unit, permitting lighting service to be maintained in the building if the main

generating plant be shut down for repairs. Drainage from this line is facilitated by both a connection to a steam pump and to a steam trap. The exhaust main practically parallels the high pressure main, consisting of a 14-in. line in the engine room, with an 8-in. branch from the engines in the front portion of the basement, and it has connection through a back pressure valve into a 16-in. atmospheric riser to a roof exhaust head and through an oil separator, to the low pressure heating main and the feed water heater. This line is also similarly drained by steam traps and the connection to the feed water heater. There has also been installed a supplementary exhaust main, consisting of an 8-in. line having duplicate connections to the exhaust outlets from the elevator pumps, which supplementary main has a direct valved connection to the atmospheric relief riser branch; the purpose of this is to permit of a sub-division of the exhaust main and allow the elevator pumps to exhaust direct to the atmosphere, independent of the disposal of the main exhaust, when little steam is required for heating purposes. The new low pressure heating main follows the general arrangement of the original heating main, except that it is enlarged to a 10-in. line in the engine room and with a 9-in. branch to the old portion of the basement; this is supplied with steam through a 14-in. connection direct from the exhaust main, with also a live steam supplementary connection from the high pressure system through an 8x12-in. pressure reducing valve.

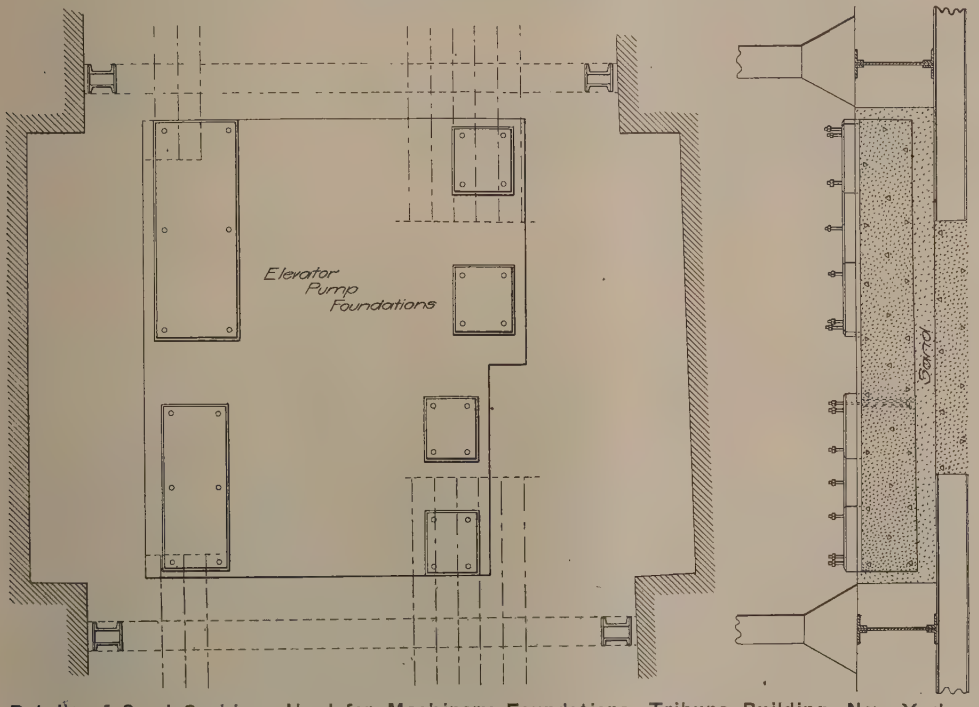
With the reconstruction of the plant, the power scheme has been entirely remodeled, with a view of electrically driving all the machinery in the building. The machinery of the pressroom and other departments of the printing plant had formerly been operated through shafting and belt drives from a large Corliss engine, with the fly-wheel of the 75 k.w. American-Ball generating unit lined up for a belt drive connection in reserve, and there were, in addition, two direct-connected electrical generating units of 40 and 50 k.w. capacity each, for operating the electric lighting service in the original building. As the Corliss engine was located in the space now occupied by pumps and the elevator equipment, it was removed early in the course of the reconstruction work, and the press load carried by the simple automatic engine, and an electrical generating equipment of nearly 500 k.w. capacity has been installed with provisions for easy enlargement in view of the possibililty of eventually replacing the belt drives if the printing plant is remodeled. For the present, however, the original presses, located in the front portion of the old basement, are still in operation, but a large space has been provided in the basement of the new Frankfort street extension to amply accommodate the proposed new printing plant. Two of the original electrical generating units, namely, the 40 and 75 k.w. machines, have been maintained in the new plant, and in addition two larger units with compound driving engines installed, which are of 125 and 200 k. w. capacity respectively. The two large new units and the 40 k. w. unit are located in the newly arranged engine room at the Frankfort street end of the basement, as shown in the basement plan, while the 75 k .w. unit was left in its original location, where it had been so placed that it might also be utilized to operate the printing plant shafting from its fly-wheel, and thus serve as a reserve power unit, while still available for generating electric current supply. The 200 k.w. generator is driven by an 18 and 28x18-in. American-Ball compound engine, which, operating at 200 r. p. m. and with a boiler pressure of 120 lb., has a rating of 325 h.p., while the 125 k.w. unit is driven by a 14 and 22x16-in. engine of similar make, that operates at 230 r. p. m. and has a rating of 200 h.p. The 40 k.w. unit that was moved to the new engine room has a 12x12 simple Ames engine, operating at 300 r. p. m. and rated at 60 h.p., and the 75 k.w. unit a 15x12-in. simple American Ball engine that operates at 285 r.p.m. and has a rating of 100 h.p.; both of these engines were designed for the steam pressure originally carried at the plant, namely, 80 lb., and accordingly are now supplied through reducing valves which reduce the pressure from 120 to 80 lb. at the throttle. The power unit by which the presses are normally operated is a 11½ and 13½x12-in. American Ball compound engine, which operates at 250-r. p. m. and is rated at 120 h.p. The two larger engines are of the improved duplex compound type, with piston valves and balanced inertia governor, built by the American Engine Co., Bound Brook, N. J.

The 125 and 75 kw. electrical generators were supplied by the American Engine Co., in both cases direct-connected to American Ball engines, while the 200 and the 40 kw. units are General Electrical generators, the 40 kw. unit direct-connected to the Ames engine. These generators are all compound wound multipolar machines, wound to deliver 120 volts direct current, and are all designed with very liberal ratings, having capacities for 50 per cent. overload for 2 hr. continuously and for 100 per cent. momentarily. The distribution is on the two-wire system throughout the building, being controlled on a handsome five-panel switchboard of Vermont marble. The board is of double bus-bar construction and has the usual arrangement of switching and indicating apparatus, and, in addition, recording apparatus so connected that the current consumptions for both power and lighting purposes may be recorded separately. Two panels are devoted to the generator circuits, a feature of the equipment of which is the use of I. T. E. reversite circuit breakers, which are designed to open the circuits in cases of a very slight amount of reverse current in paralleling the generators, and of the remaining three panels two are used at present, the two lower rows of switches being on the lighting, while the upper row is for power and the third is held in reserve for future circuits to the proposed new printing plant and other new departments. The power load of the plant is already of considerable size, there being seven individual motor drives operated in the stereotype room, using motors from ½ to 5 h.-p. capacity; two small motors in the engraving room; in the composing room four motors operating job and proof-presses and 35 ¼ h.-p. Sprague motors individually connected to linotype machines, while there are one 15 h.-p., two 5 h.-p. and two 2½ h.-p. motors operating ventilating apparatus. The lighting system will consist of a connected load of 6,000 to 7,000 16-c.p. lamps in the offices, and, in addition, 76 Cooper-Hewitt mercury vapor lamps distributed throughout the different departments of the Tribune; four of these are 700 candle power lamps, located in the clock tower for illumination of the clock's dial.

The new elevator plant that has been installed consists of eight high-rise passenger and one freight elevator machines of the plunger type, which are operated on the back-pressure discharge system, and a high-duty pumping equipment with ample reserve capacity. The machines all have full travel to the twentieth floor of the building with the exception of one passenger machine, which has a rise to the eleventh floor only, and three of the passenger machines are operated for express service, while the remaining five passenger machines are for the local service, making stops at all floors. The passenger machines are all designed for capacities of 2,000 lb. each, the three express cars to travel at a speed of 600 ft. per minute, and the five locals at 400 ft. per minute, and the freight elevator for a capacity of 3,000 lb. at 200 ft. per minute, while in addition the freight machine is fitted with a jack pump attachment, by means of which its capacity can be raised to 6,000 lb. in special cases, when lifting heavy machinery, safes, etc. These equipments were supplied by the Standard Plunger Elevator Co., New York, and embrace apparatus of the standard construction of this company, with the exception that closed discharge tanks are used in connection with the back pressure discharge system, instead of the usual open tank discharge. The plunger cylinder valves and the control apparatus for the machines are, owing to the location of the corridors in the building, arranged in the central portion of the engine room, and for convenience of piping connections, the tanks and pumps have been here located also. There are four tanks used in the operation of this system, two for the pressure supply system and two for the discharge, in all of which air space is maintained in the usual manner by means of compressed air supplied from a Westinghouse locomotive type air compressor. The main pressure tank is located in the attic of the building, a 7½x24-ft. cylindrical steel tank, to which pressure is delivered from the pump through a 15-in. delivery main and stand pipe, while the auxiliary pressure tank, a 5x10-ft. vertical cylindrical steel tank, is located in the basement, at the foot of the stand pipe, and from this tank the delivery connections are made to the control valves of the elevator machines. The discharge tanks are horizontal cylindrical steel tanks, 6¾ ft. in diameter, one 16 ft. and the other 28 ft. in length, which are mounted on a structural steel platform 6½ ft. above the basement floor level, and into these the control valves discharge through independent grouped connections. The two tanks are interconnected by a 10-in. main, to which is attached a 7-in, line that is carried up alongside of the stand pipe to a point 68 ft. above the cellar floor level to an open discharge outlet, for the purpose of securing the desired back pressure effect. The pumps are located directly underneath the discharge tanks and consist of Davidson compound duplex pumps of the separable type, so that either unit may be worked to its full or half capacity, as required by the elevator service. The larger unit is a 16 and 30x14x24-in. pump, while the smaller unit has 12 and 22x10x24-in. cylinders. The jack pump which is located alongside of the freight elevator in the rear end of the building, and is used for that machine only, is a 10x5x12-in. Davidson simplex pump.

The heating system of the building has been entirely remodeled and converted into a low pressure system, operating with exhaust steam from the power plant and with a vacuum system of condensation return. The original system in the old building was of the high pressure type, using steam at about 10 to 12 lb. pressure, with small size mains and risers and gravity returns, so that the original basement piping was entirely unadapted for extensions, and a new basement distributing system was installed. This consists of a 10-in. header that extends longitudinally through the central portion of the basement and has a 9-in. extension into the front portion of the basement, to connect with certain portions of the original heating system which have been retained in the new plant, and an 8-in. extension into the new Frankfort street extension of the building, with numerous branch connections to nearby risers in the central portion. The header has a 14-in. supply connection from the exhaust main near its central point through a Webster oil separator, and has, in addition, a live steam make-up connection from the high pressure system consisting of a 6x10-in. Kieley reducing valve with by-pass. The supply connections to radiation throughout the building are made in the usual way through 43 wall risers which receive steam directly from the basement heating header

above referred to, and for the greater part are carried up to the top of the building, with anchorages to the building framework at the fourth and thirteenth floors, and expansion joints between at the eight or ninth floors. An exception to this arrangement occurs in the old Nassau St. front portion of the building, in which portion a minimum of building changes were made, and it was thought desirable to utilize the original small size risers that were used in the high pressure heating systetm; this was accomplished by running an overhead distributing main in a mezzanine space above the twelfth floor, in which are located the series of distributing and equalizing beams that carry the steel work of the new upper stories, and feeding from this main both into the new wall risers that are carried up to the new upper stories and also back down into the small old risers from the top. In this way the old risers, which were not disturbed and proximately 1,815 short tons, in both 1903 and 1904, which amounts to a daily average consumption of 9.92 tons of pea anthracite during a period when 226 h.p. hours were produced on an average per 24 hours. On October 1 of this year a summary of the plant records for the same six months period indicates a total fuel consumption of 2,212 tons, or a daily average of but 2.16 tons, and this with the building increased to about three times its former size. The electric lighting and power load is now about 75 per cent. greater than before, while the total combined car travel of the present nine elevators is 2,030 ft., as compared with the combined rise of 360 ft. of the former three elevators in the original 10-story building, which indicates a power production on a much more economical basis—due, it is thought, to the use of compound engines and pumps and the operation with 125-lb. steam instead of 80-lb., as formerly.



Details of Sand Cushions Used for Machinery Foundations, Tribune Building, New York.

which are as small in some cases as ½ in. at the top, are successfully operated by feeding in at both top and bottom, in conjunction with the use of the vacuum system of returns. This distributing main above the twelfth floor is a 5-in. line, which is supplied by a direct 8-in. riser from the basement heating header, and from it 1 or 1½ in. connections are run to the tops of all of the old risers below, while the new risers above it are designed and connected in the usual manner. Condensation from the heating system is returned from the power plant by the Webster system of vacuum returns, return risers being run to parallel each of the steam supply risers throughout the building; these connect in the basement to a 3½-in. gathering main, which is in turn connected in the engine room through suction strainers to two vacuum pumps installed in duplicate. These pumps are Davidson 8x12x12-in. simplex pumps, which deliver the condensation first into an overhead separating tank, in which entrained air and vapor is allowed to escape, and from thence it is delivered into the feed water heater for return to the boilers. The total amount of radiation operated in the extended building is about 35,000 sq. ft., which is divided into about 1,000 heating units.

An interesting result of operation with the new plant has been obtained in a considerably reduced coal consumption. The fuel consumption of the old plant was, from records made for six months, from April 1 to October 1, ap-

In the installation of the power plant machinery in the central portion of the basement, difficulty was experienced in obtaining satisfactory foundations without interference with the grillages of the new building framework, and in order to prevent communication of disagreeable vibrations to the upper portions of the building, an interesting arrangement of sound-proof foundation construction was devised. As above stated, reinforcing framework was necessary in the rear portion of the building above the engine room, in order to carry the increased weight of the ten stories added, which consist of balanced columns carried up from new footings in the basement to the thirteenth floor without intermediate loading, at which point the weight of the new upper stories is distributed upon them by a system of equalizing girders. These columns, which were erected through the floors within the old building walls, are carried in pairs on distributing girders placed below the basement floor level, which rest on I-beam grillages that were set in excavations between the original building wall footings, in order not to disturb the original structure. The grillages consist of 15-in. I-beams 12 ft. in length, which are set longitudinally of the basement space, and as the distributing girders supported are but 20 to 24 ft. apart, it will be seen that very little space was afforded between grillages for foundation purposes. It was finally decided to locate the pump and engine foundations directly upon the grillages, taking such precautions as possible to prevent the communication of vibration from the reciprocating machinery to the upper portions of the building framework. For the latter purpose sand-bed insulation was used, there being 8-in. sand-beds provided underneath all foundations and 6-in. sand packed spaces between the edges of the foundation and any adjacent footings, beams or other building construction. This construction is shown in the accompanying detail of the elevator pump foundation, which was built in a single unit for both the larger and smaller separable compound pumps. In this case almost the entire space between adjacent distributing girders is occupied, the block of concrete overlapping the grillages on either side by nearly 4 ft. in either case.

In the construction of the foundations the spaces between the ends of the grillage beams were in all cases excavated to some distance and then concreted to an even surface, level with the tops of the grillage beams, and upon this the sand bed was placed, preparatory to the construction of the foundation blocks. The block was then constructed by erecting forms for the side and placing a water-proofing course over the sand-bed in order to prevent contact of the concrete with the sand and subsequent solidification of the latter. Upon completion, the forms were drawn at the sides and the spaces there packed with sand, the floor being finished directly across the side sand spaces. This construction was found successful, as no vibration is communicated to the upper floors, and this without sacrificing any of the stability of the foundations.

The design of the new mechanical and electrical equipment is due to Mr. Arthur S. Vincent, the mechanical engineer for the Tribune Association, under whose supervision the entire equipment was installed. The general contractors for the building reconstruction were D. C. Weeks & Sons, New York, while the heating and ventilating equipment was installed by Baker, Smith & Co., New York. The architects of the building were Messrs. D'Oench & Yost and L. Thouvard, New York.

Trade Names for Malleable Cast Iron.

A trade misnomer relating to malleable cast-iron is mentioned by Prof. Bradley Stoughton in the "School of Mines Quarterly." On account of its fluidity such iron may be cast very cheaply in small sizes, and therefore the temptation to use it as a material for "cast-steel hammers," "hard-steel" bevel gears, "semi-steel castings," and even automobile "steel" drop-forgings, is a strong one. Engineers are warned to be on their guard against a deception of this kind, for legal redress has been sought many times in vain. A clever lawyer may easily confuse a judge or jury with the involved definitions and technical descriptions necessary to make the distinction clear. It is usual for the manufacturer when putting material of this kind upon the market to qualify the name "steel" with some other letter or name, such as "P. Q. steel"; but they all differ from true steel in that they were not "cast into an initially malleable mass." Some are made by melting a large proportion of steel with cast-iron, after which the cooled metal may or may not be annealed in iron oxide. Others are made by a long or thorough annealing of ordinary malleable castings in iron oxide, by means of which the metal is decarburized to some depth, and is then carburized again by a cementation process. This makes a very good material for some purposes, such as small bevel gears not requiring strength or much ducility, but it ought not to be called "steel."

A Large Coal-Storage Wharf at Superior, Wisconsin.

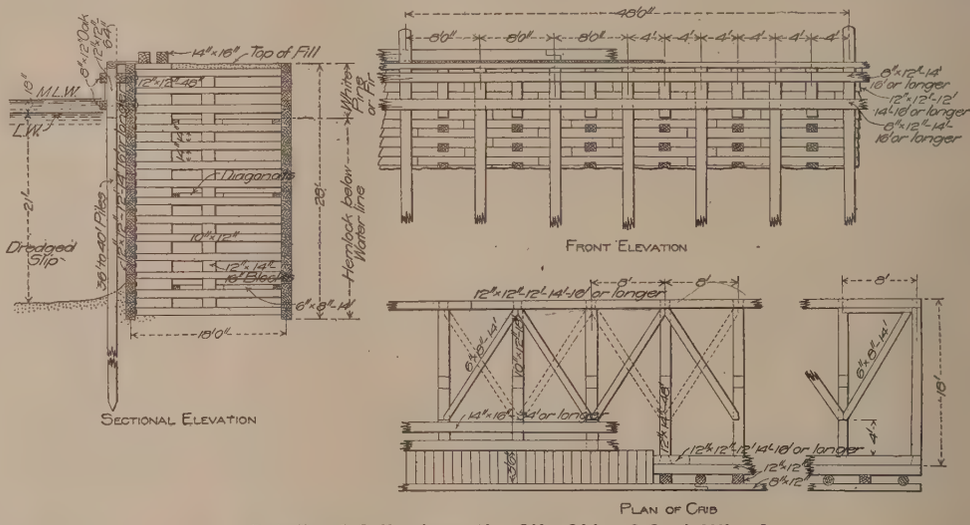
A coal-storage wharf, which has recently been placed in service at Superior, Wis., by the Berwind Fuel Co., is served by three electrically operated tramway bridges, for unloading coal from vessels and reloading it into railway cars, that are believed to be the largest and heaviest structures of this type thus far built on the Great Lakes. The site of the wharf is on St. Louis Bay, in the harbor of Duluth and Superior, adjacent to a number of other large coal-storage wharves, over which the immense coal traffic passing through Duluth and Superior is handled. This traffic reached a total of over 5,000,000 tons in 1906 and is increasing at a remarkable rate. Many of the large vessels which carry iron ore to the lower lake ports from the Messaba and Vermillion mining districts, northeast of Superior and Duluth, return with cargoes of coal. A small part of this coal is used locally, but a very large percentage of it is unloaded on wharves in Superior and transshipped by rail to the Northwestern part of the United States and Southwestern Canada.

The property on which the new wharf is located is 455 ft. wide and has a frontage of 2,700 ft. on a slip of that length, which has been dredged at nearly right angles to the dredged channel in the bay. The fuel company also owns two strips of land, one 75 ft. and the other 82.5 ft. wide, which extend from the wharf site to right-of-way of a belt-line railroad that connects with all the railroads entering Duluth and Superior. A portion of the wharf site, 1,500 ft. in length, at the shore end, has been developed as a coal-storage wharf during this year, making 682,500 sq. ft. of developed area, which should store 350,000 tons of coal. The remaining off-shore undeveloped area covers 546,000 sq. ft., and when the wharf is extended over it the total storage capacity will be about 700,000 tons.

The water was from 4 to 8 ft. deep over all of the wharf site, except for a narrow strip at the shore end where the ground rose from 20 ft. above the level of the bay. The developed portion of the site that was inundated has been reclaimed by a fill confined by tight timber bulkheads; the high ground at the shore end has been cut down to the level of this fill; cuts have been made through the narrow strips of land extending from the shore end of the site to the belt-line railroad, and two tracks have been laid in each of these cuts to provide switching connections for the wharf. The three bridges for unloading coal from vessels in the slip and for rehandling it into cars on the railway tracks span the wharf and travel the full length of the developed area, reaching out also over vessels in the slip.

Wharf Construction.—The fill which was required to develop practically all of the wharf site was carried up 5.5 ft. above mean low water in the bay. It is confined on the slip side, where the minimum depth of water is 21 ft., by a timber crib, 1,500 ft. in length, which is of unusually heavy construction, as may be seen from the accompanying illustration showing the details of it. The crib is 18 ft. wide and 28 ft. high. The sides of the crib are each formed by a row of 12x12-in. timbers, in 12, 14 and 16 ft. or greater lengths, all thoroughly drift-bolted together. The row of timbers on the slip side also has 1x6-ft. battens over the joints between the timbers to prevent the fill from filtering through these joints. The cross bracing between the two sides of the crib consists of 10x12-in. timbers, placed transversely in vertical rows, the rows being spaced 8 ft. apart on centers, the timbers in the rows being 14 in. apart. Between each two of these vertical rows of cross braces are three pairs of 6x8-in. diagonal braces, the first pair 6 ft. from the top of the crib, the second 8 ft. below the first and the third 10 ft. below the second. The cross braces in each vertical row have 12x14x48-in. blocks between them on the slip side, and also 12x14x16-in. blocks at the middle. The crib is protected on the slip side by a row of round piles, 36 to 40 ft. long, which are placed 8 ft. apart on centers, alternating with the cross braces. These piles are blocked against the side of the crib and carry two 8x12-in. oak waling fenders. Above the waterline the crib is built of white pine and fir, and below that of hemlock.

After enough of the row of protection piles had been driven to permit work to be started on the crib the latter was built up in sections, 600 ft. long, directly over the site it was to occupy. These sections floated 6 to 8 ft. out of the water when finished. They were sunk and anchored in position by material placed in them by a dipper dredge. The bottom was previously prepared, where necessary, so each section settled into place evenly and to proper alignment.



Details of Crib along the Slip Side of Coal Wharf.

View of Coal-Storage Space.

The water is 4 to 8 ft. deep on the side of the fill opposite from the slip. The fill is confined along that side by a sheet-pile bulkhead, 1,350 ft. long, which is continued along the off-shore end the full 455 ft. of the width of the wharf to a connection with the crib on the slip side. This bulkhead consists of a row of triple-lap Wakefield sheet-piling formed of 3x12-in. Norway pine in 16-ft. lengths. A row of round piles, 30 to 70 ft. long, is driven on the outside of the sheet piling as a brace and protection. These round piles are 3 ft. 10½ in. apart on centers for 250 ft. from the shore, and 2 ft. 3 in. apart on centers in the balance of the bulkhead. They are anchored to round piles, 20 to 30 ft. long, which are driven 16 ft. apart on centers in a row 50 ft. back in the fill from the row of protection piles.

The extremely heavy loads on the towers of the tramway bridges are carried by rows of heavy piling, thoroughly braced and capped. These piling foundations for the bridges are entirely independent of the crib and the sheet-piling which confine the wharf fill. They were driven ahead of the work on the fill and are cut off at the surface of the latter.

The crib and bulkhead work was done under contract by the Barnett & Record Co., of Minneapolis, Minn. The piling was driven with a hydraulic jet and a drop hammer.

The fill contains about 250,000 cu. yd. of material, 180,000 cu. yd. of which were pumped into the property by the hydraulic dredge "Enterprise." This dredge is owned and operated by the Duluth-Superior Dredging Co., of which Mr. Edward Clifford is president and was in charge of the operations. It is equipped with a 22-in. special centrifugal dredging pump, and has a 20-in. discharge line. The fill for the wharf was made by the dredge in a remarkably short time. When the Berwind Fuel Co. contemplated the construction of a wharf at the head of Lake Superior it was generally conceded by those conversant with such work in the locality that it was impossible to build a wharf of the projected size and fill it with sand in twelve months. At the time the contract for making the fill was awarded the dredge "Enterprise" was on the St. Lawrence River at Messena, N. Y., so had to be brought through the Welland Canal and up the Great Lakes. On account of the backward spring, which caused the Welland Canal to be two weeks late in opening, the dredge did not arrive until May 19, but was started in service on May 26 and practically completed the fill about August 15.

The remaining 70,000 cu. yd. of material in the fill, in addition to that supplied by the dredge, was obtained in cutting down the land at the shore end of the property and from the cuts

made through the narrow right-of-way strips for the railroad connections. Two steam shovels were installed to do most of the cutting, while some of the lighter work was done by grading machines. The material excavated by the shovels was hauled out on the fill in trains of dump cars running on narrow-gauge tracks. The grading machines were served by dump wagons in which the material was also carried out on the fill. This excavation was all made in a peculiarly difficult clay, which, when frozen, could scarcely be loosened in any quantity by blasting. The erection of the three traveling bridges and the other construction work also complicated the grading considerably, but the large amount of plant installed enabled it to be finished along with the other work.

Coal-Handling Equipment.—The coal-handling equipment consists of three traveling bridges, two screening towers and two locomotive cranes. Each traveling bridge is 506 ft. in length, from end to end, and is carried by two towers, one at the front, traveling along the slip, and the other toward the opposite end of the bridge, the clear span between the two towers being 295 ft. A section of each bridge, 64 ft. long, projects out over the slip from the front tower, and is hinged so it can be raised and lowered to permit the passage of boats with spars. The other end of the bridge is a fixed cantilever, extending 125 ft. beyond the tower leg toward that end. The front tower of the bridge has two legs, 35.5 ft. apart on centers. Each of these legs is carried by two narrow-gauge four-wheel trucks with double-flanged wheels running on rails laid on the heavy pile foundations. The other tower of the bridge is a shear leg, with two vertical posts each carried by a four-wheel truck. The following loads on these various trucks convey an impression of the size of the bridges: the total load per truck on the front leg of the front tower is 177,000 lb.; on the rear leg of this tower, 215,000 lb. per truck; and on the rear tower, or shear-leg, 336,000 lb. per truck.

Each bridge is equipped with a 3-ton clam-shell bucket carried by a trolley having an extreme travel, from end to end of the bridge, of 474 ft. These buckets are self-filling and will handle either bituminous or anthracite coal. Each bucket is arranged to handle coal in several ways. It will unload coal from the hold of a vessel in the slip and place it in storage piles between the two towers of the bridges; or in a hopper on the front tower of the bridge, from which cars on the switch track are loaded; or in the hopper of the screening tower under the cantilever end of the bridge beyond the shear leg. It will also handle coal from the storage piles into the reloading hopper, or into the hopper of the screening tower, and will convey screenings from the piles at the screening towers to either of these hoppers.

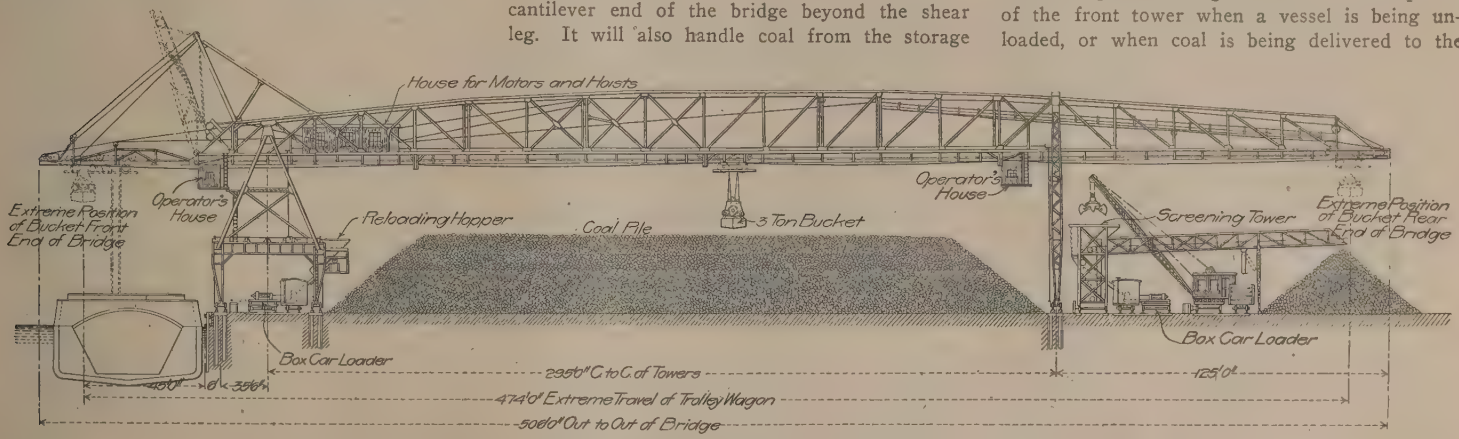
One of the salient features of the arrangement of the bridges and of the operation of the bucket carried by each of them is the provision of a hopper on the front tower through which run-of-mine coal may be loaded directly into railroad cars from the vessel. This hopper is so close to the slip that the bucket trolley is required to travel a very short distance, thus enabling a large unloading capacity to be maintained. The hopper is also built to handle large quantities of coal, and as a box-car loader is provided in connection with it, the cars can be filled from the hopper without delaying the operation of the bridge when the latter is working to full capacity.

The buckets have a guaranteed hoisting speed of 300 ft. per minute and a trolley travel of 1,000 ft. per minute. On an average of a round trip a minute and 3 tons per trip, the three bridges should handle 5,400 tons in 10 hr.

The buckets are each operated by an electric hoist, with its hoisting and holding drums controlled, respectively, by means of a hand brake and a friction clutch, the latter being shifted by a General Electric solenoid controller. The hoists are each driven by a 3-phase 25-cycle 440-volt 225-h.-p. General Electric alternating-current induction motor, which has double-reduction gearing to the hoisting and holding drums. The trolley carriage of the bucket is moved by a cable on a trolley drum driven by a 3-phase 25-cycle 440-volt 75-h.-p. General Electric alternating-current induction motor operated by a controller. The motor and hoists for each bridge are placed in a house on the bridge just in the rear of the front tower. The motor and friction clutch are arranged for remote control, the operator being in a cab on the slip side of the front tower when a vessel is being unloaded, or when coal is being delivered to the reloading hopper; and in a second cab at the shear leg when other operations are in progress.

The bridges are moved along the wharf at a speed of 50 ft. per minute by means of a 75-h.-p. General Electric alternating-current induction motor, connected to the axles of the track wheels on the front and rear towers by cast-steel gears. These motors are also arranged for remote control from either of the operator's cabs.

The two screening towers are self-propelled, and are entirely independent of all other coal-handling equipment. They are built of structural steel, each having an overhead conveyor carried by a four-leg tower at one end by shear leg near the other end. This tower and the shear leg are on wheels traveling on rails laid on the wharf. The tower carries a loading hopper and a screening pocket. The screens in this pocket are arranged with interchangeable bars, which permit practically any grade of coal to be prepared with each tower. The screenings are dropped into a hopper which deposits them on a traveling belt-conveyor, and are delivered by this conveyor to storage piles under the extreme end of the bridges, where they can be



Elevation of Coal Handling Equipment at Superior, Wis.

West Right of Way Showing Full Length of Leads.

East Right of Way Showing about Half of Leads.

reached by the 3-ton bucket carried by each of the latter. The screenings can also be dumped from the conveyor directly into cars on a track under the bridge of the screening tower. Each screening tower is designed to handle 4,000 tons of coal in 10 hr., and can be used in connection with the traveling bridges, or with either of the two locomotive cranes, which travel on a track under the bridges of the screening towers. These locomotive cranes are intended to be used exclusively for loading commercial coal when the traveling bridges are unloading a vessel, or are otherwise engaged. They are thus expected to preclude the chief objection previously made to a large traveling bridge, namely, when unloading any particular grade of coal from a vessel it was impossible to load out another grade without taking the bridge from the vessel.

Most of the coal is shipped to the Northwest from Superior and Duluth in box cars. Two portable box-car loading machines, each driven by a 100-h.-p. General Electric motor, are used in loading the cars. One of these machines travels on a track parallel with the track which serves the hopper of the screening towers; the other is on a track on the opposite side of the wharf next to the track for cars supplied from the reloading hoppers on the front towers of the bridges.

The electric power to operate the various coal-handling equipment is delivered to the dock as 25-cycle 3-phase alternating current at 13,200 volts, by the Great Northern Power Co. of Duluth. The current is received in a fireproof transformer house containing three General Electric 3-phase oil-cooled 500-kw. transformers for stepping the current from 13,200 volts down to 440 volts. Each transformer has four 2½ per cent. primary taps and two 4 per cent. secondary taps. A five-panel switch-board is also provided in the transformer house. One panel of this board, which is equipped with indicating and recording instruments, is for the high-tension incoming line. An automatically motor-operated oil switch for this line is placed in concrete cells. A multiplex lightning arrester is also provided for the high-tension line. The other four panels of the board are each for a feeder circuit, each panel being equipped with an ammeter, a circuit breaker and a main-line switch.

The following four buildings were also erected in connection with the dock: a machine shop, equipped with a traveling crane, planers, lathes, drill presses and forges, permitting all necessary repairs to the equipment to be made in this shop; a store house, equipped with a traveling crane of sufficient capacity to handle any piece of machinery or extra parts for the dock equipment; an office and service building, divided into two parts, one for the necessary accounting, and the other for toilet, running water and comforts for the laborers; and an oil storage house, isolated from the remainder of the buildings. All of these buildings and the transformer house are thoroughly fireproof, having brick side walls and book-tile roofs; the machine shop also has a steel frame.

The contract for the three traveling bridges, the two screening towers and the two locomotive cranes was awarded to the Dodge Coal Storage Co. of Philadelphia. Coal was unloaded from the steamer Joe S. Morrow by all three bridges on August 13, two days prior to the date originally contemplated. The wharf and all of the equipment were practically complete at that time, six months after the contract was awarded. The early completion of the work was largely due to the efforts of Mr. C. J. A. Morris, of St. Paul, Minn., who was appointed chief engineer of the project for the Berwind Fuel Co., and personally supervised the construction from its inception. The structural steel work was all fabricated and erected under a sub-contract by the Morava Construction Co., of Chicago, which company completed the work in contract time, although erection was not commenced until April 23.

This journal is indebted to Mr. F. G. Hartwell, president of the Berwind Fuel Co., for permission to visit the wharf and collect the data from which these notes have been prepared.

Macadam Roads in King County, Wash.

A short resume of the principles and methods of macadam road construction and the cost of a number of roads, formed the subject of a paper by Mr. A. L. Valentine, county engineer of King County, Wash., before the last convention of the Pacific Northwest Society of Engineers, Seattle. The paper was printed in the September, 1907, issue of the proceedings of the Society, from which these notes have been taken.

The broken stone used in King County is graded into three sizes, No. 1 passing a 3-in. ring, No. 2 a 1½-in. ring, and No. 3, which contains all the dust of fracture, including stone passing a ½-in. screen The bottom course of the road is made of No. 1 stone, and the course of No. 2 contains only a sufficient quantity of stone to fill the voids of the lower course. Experience in King County has shown that an allowance of one-third of the desired thickness of the completed roadbed is necessary in the loose stone, to allow for shrinkage in rolling, so that 9 in. of loose stone are used where a completed bed of 6 in. is desired. The work is started at the end farthest from the source of supply, so that in the earlier stages of construction there will be no traffic to form wheel ruts in the first and second courses, which may be easily injured even though they have been rolled.

The costs and quantities which follow are given by Mr. Valentine for macadam roads in King County.

One road 6,600 ft. long, with 16-ft. stone bed 6 in. deep, contained, including turn-outs, 12,006 sq. yd. Total number of cubic yards used was 3,048. In this instance one cubic yard covered 3.93 sq. yd. The proportion of stone was 66 per cent. of No. 1, 25 per cent. of No. 2, and 9 per cent dust. The cost per square yard was as follows: Stone, 0.44427 cents; rolling, 0.03823 cents; sprinkling, 0.01388; spreading, 0.04043; hauling, 0.08536; total cost, 0.62217 cents. Adding 25 per cent. for contractor's profit, gives 0.7777 cents per square yard, or a cost per mile of $7,300 for the stone bed only. This represents the cost after the roadbed had been shaped and was ready to be rolled. The stone was delivered at station 24, making the greatest haul 4,200 ft., station 0 being the beginning.

Another section of road, 4,800 ft. long, was constructed during the wet season and contained 1,869 cu. yd., used in the following proportions: Seventy-eight per cent. No. 1, 18 per cent. No. 2 and 4 per cent. dust. It will be noted there is considerable difference in the quantity one course bears to the other, as compared with the previous figures. This difference is caused by using just enough of course No. 2 and the binder to fill the voids. Taking the number of cubic yards actually used (1,869), and at the rate for carload lots, delivered, $1.75 f. o. b. cars, we have the following costs per square yard: Stone, 0.381 cents; rolling and sprinkling, 0.084 cents; hauling and spreading, 0.166 cents; total cost, 0.631 cents. This cost represents a maximum haul of 4,260 ft. in one direction and 3,700 ft. in the other, the stone being delivered on the road between these points. In this instance, one cubic yard of stone covered 4½ sq. yd.

This also includes the following labor cost: Foreman, $4.00; rollerman, $3.50; spreadermen, $3.00 and $3.50, and teams at $7.00 per day of ten hours. No superintendence, interest on money invested or contractor's profit is added. Adding a contractor's profit of 25 per cent. we would have 0.788 cents, or a cost per mile of $7,400, for the stone bed only.

Another road exactly one mile long was constructed during dry weather. The road had been built two years and was but 10 ft. wide, with a 6-in. stone bed. It had been entirely covered with water during floods, and the roadbed exposed to the wash of the river current. This washed away the binder and softened the bed so that it was badly rutted. Owing to these conditions it was considered best to increase the width to 16 ft. This meant an increase in the crown and practically an entirely new road, both as regards quantity of material and labor. The entire bed was scarified by hand; that is, laborers were employed at $3.00 per day of ten hours to pick up the stone bed before the first course was spread. This cost would about offset the cost of rolling the sub-grade of a new road, so that the item of sub-grade rolling shows in the summary of cost, but is really included in spreading and scarifying, and the cost of rolling is reduced in that proportion.

The total number of cubic yards of stone used was 1,792, in the following proportions: 72 per cent. No. 1, 22 per cent. No. 2 and 6 per cent dust. The longest haul was 3,970 ft., the stone being delivered at stations 39 plus 70 and hauled each way; that is, to stations 0 and 52 plus 80. Cost of stone delivered f. o. b. cars at station 39 plus 70 was $1.75 per cubic yard; wages of foreman, $4.00; rollerman, $3.50; teams, $7.00, and laborers, $3.00 and $3.50 per day of ten hours; cost of water, 15 cents per tank of 600 gal.; coal for roller at $6.50 per ton. The cost per square yard was as follows: Rolling, 0.0333 cents; sprinkling, 0.0269 cents; hauling, sprinkling, spreading, 0.1695 cents; stone, 0.3340 cents; total cost, 0.5637 cents. Adding 10 per cent. to cover shrinkage and incidentals necessary on a new road on an ordinary foundation, or $5,820.59 for one mile, and 25 per cent. for contractor's profit, we would have 0.770 cents per square yard, or $7,275 per mile.

On this road there was used 1,792 cu. yd. of stone. Had it been an ordinary foundation, allowing one-third for shrinkage, we would have used 2,080 cu. yd. One tank of water covered 64 sq. yds., or 9.33 gal. covered one square yard. figuring each tank at 600 gal. One ton of coal was sufficient for rolling 383 sq. yd. Each cubic yard of stone covered 5.23 sq. yd.

From these figures it appears safe to estimate the stone bed at 80 cents per square yard, or $7,500 the mile, haul not exceeding 4,200 ft. and stone costing $1.75 per cubic yard.

The New Shipbuilding Plant of Yarrow & Co., Ltd., on the river Clyde, is now nearing completion, the buildings being finished, though much of the machinery is not installed. The plant is entirely new and when in full operation the old works on the Thames will be closed, the reason for the removal being the high cost of coal, material, property and labor at the latter point. The new works will be operated almost entirely by electric, hydraulic and pneumatic systems, the pumps and compressors being motor driven. Several unusual features are introduced, notably the installation on each machine in the shops of a gas jet in addition to the regular electric lights. The firm's experience, according to "The Engineer," London, is that workmen, on the whole, work under better conditions as to light and general convenience with gas than with incandescent or arc lamps. Another unusual feature is the use of bare copper wiring in the shops wherever it can be safely used.

Experimental Purification of Boston Sewage.

The Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology was founded in 1902 by an anonymous donor for the purpose of making experiments upon improved methods of sewage disposal, especially those adapted to large cities. A large part of the work of the staff has been devoted to the study of the more purely scientific problems, chemical, bacteriological, and hydraulic, which underlie the practice of sewage analysis and sewage purification. These has been carried on, however, along with these theoretical investigations, an experimental study of the immediate local problems of sewage disposal as seem likely some day to confront the city of Boston, and on November 15 a paper on this study and some deductions from it was presented to the Sanitary Section of the Boston Society of Civil Engineers by Messrs. C. E. A. Winslow and E. B. Phelps. An abstract of this paper follows:

The sewage of the metropolitan district of Boston is at present discharged untreated into the waters of the harbor at three different points. The main outfall sewer of the North district carries some 50,000,000 gal. daily and discharges continually off Deer Island. The sewage from the High Level district passed out to Peddock's Island, near the southeastern limit of the harbor; this amounts to about 20,000,000 gal. The main outfall of the south metropolitan district is at Moon Island, nearer the center of the harbor, and here the sewage is stored in masonry tanks and discharged only on the turn of the tide. The daily flow in this sewer is in the neighborhood of 100,000,000 gal. The Massachusetts State Board of Health investigated the condition of Boston harbor in 1905, and found no serious damage from this method of disposal. The town of Wellesley has, however, recently been refused admittance to the metropolitan system from fear of overtaxing the purifying power of the harbor; and it can scarcely be doubted that the progressive increase of population within the drainage district itself will ultimately bring the problem of sewage purification to the fore. The present agitation in regard to the pollution of New York harbor, under somewhat similar conditions, is an indication of what must some day be expected in Boston.

Under these circumstances it is important to form a general idea beforehand of what a proper purification of Boston sewage will involve; and the investigations at the Technology Station have reached a point at which this can approximately be determined. The detailed results of the work will shortly be published in full in the "Technology Quarterly." The general conclusions, as reported to the Sanitary Section of the Boston Society of Civil Engineers, are as follows:

Trickling Beds.—The main result of this investigation has been to show the feasibility of treating Boston sewage on trickling beds so as to secure organic stability. In the experiments conducted, the filters were operated at a rate of about 2,000,000 gal. per acre per day, which would call for 50 acres of stone beds for the treatment of the sewage now discharged at Moon Island. A comparison with the problem of constructing 133 acres of contact beds, or 1,000 acres of sand beds which would be necessary for other processes, indicates clearly that for this city the trickling bed offers the most practical method of treatment.

It has been found that with good distribution, a trickling bed 8 ft. deep will operate successfully at all seasons, under local weather conditions. It removes about half the soluble organic matter, yielding an effluent which is somewhat turbid, but stable and well oxygenated. The organic matter present has been so worked over and purified by the bacteria in the filter as to be non-putrescible. Judged by the methylene-blue reduction test, 90 per cent. of the samples of the effluent are of such stability as to undergo no putrefactive change when kept closed up from the air for four days. Under ordinary conditions of discharge into open water such an effluent would be entirely unobjectionable.

The proper distribution on trickling beds can be attained either by the use of fixed sprinkler heads of the Columbus type, so arranged as to discharge intermittently at frequent intervals, or by the use of the splashing gravity distributors designed at the experimental station for this purpose.

With good distribution the trickling beds show no appreciable tendency to clog. During the greater part of the year solid matter accumulates on the surface of the stones throughout the bed, but when this storage reaches a certain point, usually in the early spring, the solids break away and come off in the effluent in a stable condition. In a period covering two years, the total amount of solid matter coming off balanced that going on. The filtering material at the end of the experiments was in excellent condition and showed no storage of nitrogen.

The results point strongly to the advantage of operating trickling beds under conditions as uniform as possible. Resting periods proved distinctly detrimental to the work of the beds, and constant operation is recommended rather than any process which involves alternate working and resting periods.

Septic Tanks.—It appears from the experiments that Boston sewage may be treated in the septic tank with excellent results, and that a period of 7 hours is a sufficiently long one. Thus operated, an open tank will remove 40 per cent. of the total suspended solids and 60 per cent. of the fixed suspended solids; its effluent shows a decrease of about 25 per cent. in organic nitrogen in solution and a corresponding increase in free ammonia. The septic action on the stored solids is an active one, four-fifths of the organic solids deposited disappearing in solution or as gas. Fixed solids gradually accumulate so as to render it probable that tanks would require cleaning about once in two years.

On the whole, however, the experiments indicate that the septic tank need not be used at all in the treatment of Boston sewage. Since November, 1906, when the distribution system was put in order, crude sewage has been treated on one of the trickling beds with perfect success. On the whole, the effluent from this filter was less frequently putrescible than that from the bed which received septic effluent. Furthermore, the filter taking septic effluent showed a deposit on its floor, due to secondary reducing changes, which was absent from the crude sewage bed. In addition, the absence of the odors produced by spraying septic sewage is an advantage of considerable moment in favor of the process of treating fresh sewage. Combined with the saving of the cost of tanks, in the neighborhood of $250,000, these argments seem to indicate the treatment of crude sewage directly on trickling beds as most desirable. Modern devices for ensuring a thorough preliminary screening should, however, be installed.

Sedimentation of Trickling Effluents.—The suspended solids which appear in the trickling effluent, though inoffensive, are unsightly and in many locations might require removal. By a sedimentation of two hours it has been found possible to remove about half the suspended solids. This clarification was accompanied by an improvement in stability.

In the case of Boston, the currents of the harbor would be amply competent to care for the solid matter discharged if that matter were of an inoffensive and non-putrescible nature. Experience with the system at present in use has indicated this quite clearly. For a comparatively slight improvement in stability, it does not appear justifiable to go to the expense of installing secondary sedimentation tanks. The sludge accumulating in such tanks would amount to 2 or 3 cu. yd. per million gallons of effluent, a serious problem in itself. It is therefore considered by Messrs. Winslow and Phelps that the effluent from the trickling beds may best be discharged directly into the harbor as it comes from the beds. A stable effluent under such conditions could cause no nuisance and if a submerged discharge were provided its presence would scarcely be detected.

Disinfection of Trickling Effluent.—The problem of bacterial purification still remains to be considered, since the trickling bed produces organic stability without destroying pathogenic bacteria. In the case of Boston harbor, with its large contiguous population, its bathers, and its shellfish industry, this aspect is an important one. The experiments carried out during the last two years have made it clear that the effluents from trickling beds may be so purified bacterially by disinfection with chloride of lime as to be of much better quality than the present stream entering Boston harbor. This bacterial purification requires about five parts of available chloride per million gallons and the cost of treatment would be within moderate limits.

The process of disinfection with chloride can be applied to crude sewage, as well as to trickling effluent, although experiments carried out at the station indicate that about double the amount of chloride is needed on account of the reducing action of the organic matter in the sewage. Pending the construction of a trickling filter plant for the treatment of the organic matter in Boston sewage, it might well be purified bacterially by this process at the present Moon Island outfall.

General Plan for Treatment.—The sewage outfall of the South metropolitan district at Moon Island is the one which threatens most seriously to menace the purity of Boston harbor; and it is this sewage which will certainly first require some different method of treatment. Messrs. Winslow and Phelps have therefore considered in a general way the practical problem of dealing with this sewage in the light of the results of their experiments.

The most convenient location for a trickling filter area would be at the Calf Pasture in Dorchester, near the present pumping station. This is objectionable, however, on account of its proximity to the thickly settled portion of Dorchester. Furthermore, the necessity for excavating about 10 feet of mud and refilling in its place would greatly increase the cost of construction at this point. The same objections apply to certain waste areas on the Neponset marshes which suggested themselves as possibly available. The headland of Squantum would offer an ideal opportunity for building trickling beds, but the difficulties of obtaining land in another town militate against the use of this site.

The southern portion of Thompson's Island would furnish a location free from all the objections to which the other sites are open. On an embankment 1,500 ft. long the sewage could be carried from Squantum across to the island, the effluent flowing back along the same embankment to the existing outfall sewer. The pumping station at Dorchester and the tanks and outlet at Moon Island could thus be used without substantial changes. Preliminary estimates of the cost of building 50 acres of trickling beds, 8 feet deep and equipped with the gravity distribution system, including the embankment with its two sewers, an efficient grit chamber, a reasonable purchase price for the necessary land, grading, stone filling brought to the island by water, con-

crete construction, and sprinklers, are in the neighborhood of $1,800,000.

If this capital sum were borrowed at 5 per cent. on a 25-year loan, the annual expense for interest and sinking fund would be $126,800 a year, paying off the entire cost in the 25 year period. As a matter of fact, the authors of the paper see no reason to suppose that at the end of this time the plant would not be good for another 25 years without substantial reconstruction. The cost of operation, including extra pumping and supervision would amount to $70,000 a year, bringing the total cost to about $200,000 a year, or $5.50 per million gallons of sewage treated.

The effluent from the trickling beds, wherever situated, could be further bacterially purified by disinfection with chloride of lime, at a cost of approximately $1.50 per million gallons, or $55,000 annually.

Pending the construction of filters for the removal of putrescible organic matter from Boston sewage, if it should seem desirable to secure bacterial purification, this may be effected by direct treatment of the crude sewage with chloride of lime, which could probably be done for $3.00 per million gallons, or $110,000 annually.

Experiments are now in progress at the Experiment Station to test the practicability of higher rates of filtration and shallower beds than those used in the experiments on which these calculations are based, as well as on the treatment of sewage and effluents by electrolytically produced chloride. It it hoped that these experiments may lead to a material reduction in the estimated cost of the purification processes. It seems clear, however, that the combination of trickling filters and chemical disinfection will solve the Boston sewage problem satisfactorily; and in the light of present knowledge these two methods are the most efficient and economical available for the purpose.

Book Notes.

A little pamphlet which will prove particularly useful to mill architects and others who use tin roofs to a considerable extent has just been issued by the joint committee on tin plates of the National Association of Master Sheet Metal Workers of the United States. The pamphlet gives a brief history of tin roofing, discusses its advantages, and then gives an excellent set of standard specifications, well illustrated, prepared by the trustees of the association after long study for the purpose of indicating the best method of securing the highest grade of material and workmanship in such roofs. There are also practical hints regarding methods of carrying on construction, published for the benefit of contractors. Copies of this pamphlet may be obtained by addressing the president of the Association, Mr. E. L. Seabrook, 2,213 Chestnut St., Philadelphia, Pa.

A second edition of "Tables for Engineering Calculations," which has recently been brought out by Mr. Richard C. Powell, is a revision and amplification of a hand-book which he compiled with Mr. Wm. E. Hawley some years ago. The new edition is about twice the size of the first and contains additional tables which the experience of the author and the criticisms of other engineers have indicated to be useful. The section on hydraulics has been compiled in large part by Professor LeConte, of the University of California, while the tables of rolled steel sections have been furnished by the Cambria Steel Co. The book is likely to be particularly useful to engineers engaged in hydraulic power work. About half of the book is made up of natural and common logarithms of numbers and trigonometrical functions, functions of natural numbers, an excellent collection of conversion factors, and other mathematical tables and formulas. The remainder is made up of information relating to the strength of materials, the properties of steam, and electrical and hydraulic data. Special care has been taken to arrange this information in a handy shape, and to check it to avoid errors. The object of the author has apparently been to bring together in a compact form the tables and formulas likely to be of general use in the office of a designing engineer, and to leave for the reference library such rules and tables as are required but rarely. (Berkeley, Cal., R. C. Powell, $2.00.)

A good many readers of The Engineering Record are probably aware that the French methods of designing walls, dams and barrages have received much study by specialists. A well-written presentation of the current opinions in that country on this subject will be found in the volume on "Barrages en Maconnerie et Murs de Reservoirs," by Mr. H. Bellet, an engineer whose visit to this country about eighteen months ago will be recalled by a number of readers. The author first takes up the general problem of calculating the cross-section of a masonry dam and in the second chapter there is a brief discussion of the advantages and drawbacks of dams of different materials. Seven chapters are then devoted to a historical review of masonry dam design, beginning with the early works in Spain and France and then taking up in detail the profiles planned by eminent French engineers and carried out in one or more structures. This portion of the book is equally explicit regarding theory and actual construction, and will be found of particular interest to those who desire to become acquainted with the views that have been developed in France. Next there is an elaborate theoretical analysis of dams both straight and curved in plan, in which the author refers to similar work done by other French engineers and thus rounds out his own analysis in a comprehensive manner. This theoretical study is followed by a description of a large number of structures, mostly European, but including some American examples and a few from Great Britain. The practical design of dams is next taken up and attention is given to those features of design and construction not previously discussed. The volume closes with the regulations of the French government controlling the construction of dams and demonstrations of a number of the more important formulas in the work. It is unnecessary to critically review the mathematical work of the author in this volume, as it follows very largely the accepted French practice. Design of masonry dams of considerable height in France is based rather more completely on methematical analysis than is the custom in the United States, and for this reason the volume under review will be found a particularly interesting one. (Grenoble, France, A. Gratier & J. Rey, 8.25 francs.)

Letters to the Editor.

Sheet Piling and Earth Pressure.

Sir: In your discussion on Nov. 16 of the paper by Mr. J. C. Meem on "The Bracing of Trenches and Tunnels, with Practical Formulas for Earth Pressures," it seems to me that you have misunderstood his views in two points. You state that in the case of dry, sandy material he would employ "the generally accepted theory of earth pressure, the law of whose variation with the depth below the surface is similar to that of liquid pressure." As a matter of fact, Mr. Meem's paper does not admit at any time that earth and aqueous pressures are allied, although it agrees with the common theory of hydrostatic pressures in saturated soils. The opinion of the author of the paper also seems to be that the drier the sand the more it tends to wedge itself between the sheeting and the natural slope line and throw a series of arches to hold itself up. This also applies to the 'internal cohesion" of the particles. It will be noticed that the author does not make much use of this arch action, except as increasing the factor of safety, but depends on the tightness of the sheeting and bracing to hold the upper masses of material in place while working below. Of course, there must be a theoretical movement, which gives what the author terms "external coherence" by tending to produce the wedging action above mentioned.

It seems to me that the theory of Mr. Meem gives results more in harmony with observed conditions than the older theories based upon assumed conditions in the earth that very rarely, if ever, exist. It is directly at variance with the theories of high authorities, approved by long use, but why should it not be accepted if it accords best with those conditions observed in practical work? Foundations.

Garbage Reduction in Toledo.

Sir: Referring to Mr. Cook's interesting article in your issue of Oct. 12, on the "Garbage Reduction Process at Toledo," I beg to suggest that, instead of saying "the garbage at Toledo, Ohio, is treated by the reduction process, etc.," you should change this to the past tense. Mr. Cook comments upon the commercial aspect of garbage reduction by mentioning the fact that a receiver had to be appointed to take charge of the company's affairs; but concerning the sanitary aspect of the system it may be of further interest to your readers to know that, in spite of the elaborate precautions which were taken to prevent offense from the workings of the plant, it was enjoined by the courts as a nuisance and went out of commission last July, since which time the city has returned to the primeval method of dumping garbage on farm lands.

When the city entered into this reduction contract (some three years ago), it looked as if it were a very favorable arrangement, as the reduction company agreed to receive and dispose of the garbage free of charge. But, owing to the fact that the reduction system was to be employed, it was found impossible to find an advantageous location for the plant, which was finally built so far from the center of production that the average cost of hauling the garbage to it has been, I am told, about $1.30 per ton; in contrast with which other cities have found it possible to conduct centrally-located incinerating plants at a less cost per ton, including both the collection of the garbage and its final destruction by a process which also enables the city to dispose of combustible rubbish, waste paper, etc., which a reduction plant cannot receive.

In my opinion, it is to the principle of destroying municipal refuse by fire that we must look for a satisfactory solution of this knotty problem, at least in all except our very largest cities, which still show some possible promise of producing organic garbage in sufficient quantities to cover the heavy expense and depreciation incidental to a reduction plant, when all conditions are distinctly favorable.

Yours very truly,

Toledo, Nov. 19. George V. Rhines.

Graphic Solution of a Problem in Hydraulics.

Sir: In a recent test in the Engineering Department of the University of Montana it was necessary to determine beforehand the exact distance to one-hundredth of an inch that a wooden ball, as shown in the sketch, would sink when placed in a measuring tank, as the gauge attachments for measuring the outflow of water were connected to this float. The ball was carefully designed and trued up to a 4-in. radius. The material of which it was made was wood found to have a specific gravity of 0.62. The dis-

tance z to which the sphere will sink when placed in water will be such that the exact weight of the displaced water will just equal the weight of the wooden sphere. The solution of this, however, leads to a cubic equation and a method of attack was then sought for that did not involve higher mathematics. The method as shown in detail will be found useful not only in solving any cubic equation, but, in fact, an equation of any degree whatsoever.

Let r be the radius of the sphere, which is 4 in.; w will be the weight per cubic foot of water, W be the weight per cubic foot of wood, and s be the specific gravity of the wood, which is 0.62.

The volume of a segment of a sphere of depth z is $\pi\ (rz^2 - \frac{1}{3}z^3)$. The volume of a sphere is $\frac{4}{3}\pi r^3$.

Since the weight of the sphere is equal to the weight of the displaced water, $\pi\ (rz^2 - \frac{1}{3}z^3)\ w = \frac{4}{3}\pi r^3 W$.

Clearing fractions and cancelling $z^4 - 3\ rz^2 + 4\ r^3 s = 0$.

Substituting our particular values for r and s we have the following cubic equation:

$$z^3 - 12\ z^2 + 158.72 = 0.$$

The easiest way and the way that is sufficiently accurate for handling equations of this sort and of higher degree is to divide the equation into two parts, thus:

$$z^3 = 12\ z^2 - 158.72 \quad \text{.....I.}$$
$$-y_1 = z^3 \quad \text{.....II.}$$
$$y_2 = 12\ z^2 - 158.72 \quad \text{.....III.}$$

Now it is easily seen by looking at equation I that if we find a value of y_1 that makes equation II reduce to zero and an equal value of y_2 that makes equation III reduce to zero, this value when substituted in equation I will make it also reduce to zero. In other words this is one of the values of z we are looking for. In the diagram the two equations II and III have been plotted to the same scale with values of y as ordinates and z as abscissas. Now by looking carefully at the plot, we see that the two curves cross each other at three places. Hence each one of these values is a solution of equation I.

Scaling these off we find: $z_1 = -3.23$, $z_2 = +4.65$, and $z_3 = +10.58$.

As a check that these values are correct their sum should be equal to the second term in equa- I which is $+12$. As the sum of the above three values gives $+12$ we conclude that they are correct as far as they have been carried out, since there are no exact roots in the above equation.

The only possible value for our float is thus seen to be 4.65 in.

Robert Sibley.

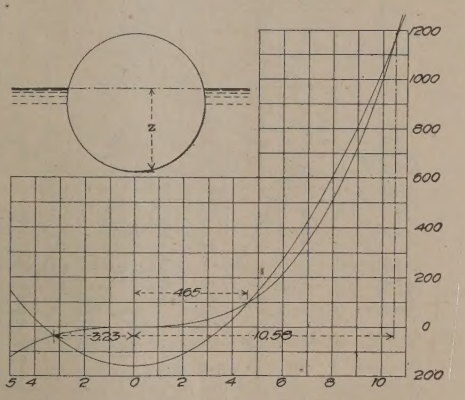
Missoula, Mont.

Treating Wood Paving Blocks.

Sir: In the paper on "Requirements for Treating Wood Paving Blocks" in your issue of Nov. 16 I find several valuable suggestions on a matter which, at this particular time, is attracting considerable attention in New York City, and I would like to add a trifle on this subject and also to correct a statement which appears in the paper to the effect that Brooklyn is using, or has used recently, the specification which is referred to in the table showing the comparative requirements of several cities as to class of timber used, treatment, etc.

Early in 1906 I found this Brooklyn specification for wood block, as quoted, in vogue. It was, I believe, Mr. Tillson's own specification, having been compiled for the borough in 1903. This old specification I promptly concluded to be defective, in that (1) No provision was made for seasoning timber for paving blocks; (2) "All heart" long leaf pine was required, which was not procurable except with great waste of material in cutting blocks; (3) In allowing no other class of timber to be used in competition with this high-priced timber; (4) In calling for treatment of unseasoned blocks with an antiseptic waterproofing mixture, of which 50 per cent. might be creosote of uncertain quality or specific gravity; (5) In using in this mixture 50 per cent. of resin, which is more costly than creosote and not of equal value as a preservative; (6) In allowing a variation of only one inch in the length of the blocks, thus adding to the cost and waste in cutting from merchantable timber and in allowing blocks as thin as 2½ in., which would tend to warp and check under traffic; (7) In making no provision for waterproofing the joints; (8) In bedding the blocks on an unstable mortar bed, composed of only one part of cement to four parts of sand; (9) In providing a concrete base only 4 in. in thickness.

In taking this matter up in Brooklyn I advocated the use of Southern black gum as a cheap alternative for long leaf yellow pine, and urged as a substitute for a light or volatile creosote oil a heavier creosote oil unmixed with resin, advocating also a waterproof joint between the blocks, which were to be laid on a thoroughly mixed and richer mortar bed, carried on at least



Solution of Hydraulic Problem.

5 in. of concrete as a minimum foundation, and I had the department chemist conduct tests of the heavy creosote oils so as to determine their value and permanency as a substitute for the lighter oils and resin called for in the old specification. Through my efforts in this direction, with the co-operation of Mr. Tillson, a specification was compiled in 1906, which has been in print for some time, containing the following requirements for wood paving blocks:

1. Well seasoned timber of long leaf pine, Southern black gum or tamarac.

2. An allowance of 10 per cent. for maximum volume of sap wood in blocks (which restriction should not, however, be applied to the black gum).

3. No blocks shorter than 6 in. or longer than 8 in., and no variation from the depth of the block or the width, so as to secure an even surface and close transverse joints throughout.

4. A straight creosote of 1.12 specific gravity at 68 deg. F., of which not less than 20 lb. to the cubic foot of timber is required.

5. A maximum absorption by a treated block of 3 per cent. when dried at 100 deg. F. in a ventilating oven for 24 hours. (This requirement, as Mr. Tillson says, is a valuable test.)

6. No burden on the contractor for cost of inspection at the works, the city to assume this expense directly.

7. A strong mortar bed of one part of cement to two and a half parts of screened sand, all carried on a 5-in. concrete base.

The comparison with the so-called Brooklyn specification seems unfair, as it had been obsolete for more than a year.

After many inspections of pavements of this class and visits to several block plants, it would seem that the defects in wood block pavements as produced to-day for the several boroughs of New York City are due in a great measure to the lack of selection and seasoning of the timber before treatment and to the steaming and softening of the fiber under a continuous high temperature, to which the raw block is treated under what the old Manhattan Borough specifications peculiarly designated as "dry heat, i. e.:

"In preparing the blocks to receive the creosote mixture they shall be placed in an air-tight cylinder, in which dry heat, or heat produced by superheated steam, is maintained and raised to a temperature of 215° Fahr., for one hour, for the purpose of expelling moisture; the heat is then to be increased until it has reached 285° Fahr., this heat being maintained for a period of three hours, or until the block is completely sterilized. Application of heat is then to be stopped and the temperature of the cylinder allowed to fall for one hour, or until the same has been reduced to 250°.

Some instructive tests on railroad ties and samples therefrom, conducted under Mr. Pinchot of the U. S. Forestry Service, indicate that in wood block treatment as practised by several of our producers to-day, where high temperatures are maintained in the impregnating cylinder carrying the green blocks, the great amount of comparative free water carried in the blocks gives a soaking or steam treatment for this long period of five hours, which has a permanent and deleterious effect upon the fiber. It must in effect be practically a steam treatment.

At the Yale Forest School this deterioration in strength of the timber has been noted, and it is found that if "the steam process has not been excessive" subsequent seasoning by a drying process will restore the greater part of the strength of the timber lost by the high steam treatment.

In the tests also of the Forest Service at the Louisiana Purchase Exposition it was found, with the original strength of loblolly pine ties taken at 100, the strength after 10 lb. steam pressure for a period of four hours, was reduced to 89 lb., and with 100 lb. steam pressure for four hours it was reduced to 41 lb. The increase in strength of seasoned or kiln-dried timbers is too well known to need comment. Re-soaking with water lowers the seasoned timber to a very material extent, but on thorough soaking with creosote the strength is but slightly reduced.

I note these features and the need of getting some more definite information on this subject than is at the present time at hand, and believe that radical changes will shortly ensue in the process of manufacture of city paving blocks. What we require is a thoroughly seasoned, thoroughly sterilized and waterproofed block of high compressive strength, but not too smooth on the end of fiber, with low cost as a first and last requirement.

I am of the opinion that Southern black gum will fill fairly well the need for competition against high-priced long leaf pine and greatly reduce the cost, with good results in durability on the street. Yellow pine specifications must be adapted to this new timber as to the amount of heart or sap, and as the specific gravity is less a properly treated block may not sink in water. Anything more than 20 lb. of heavy oil would seem to be an extravagant treatment, except for very heavy traffic streets, and some less expensive and perhaps inactive filler might be found as a substitute for resin, to be mixed with heavy creosote oil.

In some averages taken by me at the works, comparatively green long leaf pine and black gum timber, said to have been cut three months and exposed to dry weather, showed weights per cubic foot respectively of 51 and 59 lb. These

weights would be reduced in the pine from 51 lb. to perhaps 43 or 44 lb. and in the gum from 59 lb. to about 38 lb. if blocks were actually seasoned before injection of the creosote. Tests we now have under way will shortly throw more light on the comparative weights of (1) green, (2) steamed and vacuum drawn, and (3) treated blocks.

A wise move has been made by the Municipal Engineers in an attempt to establish uniform highway practice throughout the city, several engineers of the boroughs acting ex-officio on this committee, and it is hoped that a thoroughly practical standard specification will be given out during this winter for the coming season, which will be alike beneficial to the city and to the manufacturer, in settling several vexing questions as to the necessary seasoning for raw timbers before treatment—as to the amount of resin, if any, and the quantity and quality of creosote oils necessary for the several classes of timber suitable for paving blocks.

Respectfully, R. W. Creuzbaur,
Consulting Engineer of Public Works.
Brooklyn, Nov. 20.

Hydraulic Diagram for Circular Pipes.

Sir: In the accompanying diagarm, the results of the Hazen-Williams formula for flow in pipes, $v = c\, r^{0.63}\, s^{0.54}\, 0.001 - ^{0.004}$ are represented graphically. It is the writer's opinion that a properly prepared diagram has decided advantages over tables or even slide rules specially made for the formula. The relations of the discharge, slope, diameter and velocity are presented in the diagram instantly and clearly; and the effect of a modification of one of the factors on the values of the other factors is readily obtained.

In the above formula, c is a constant, the value of which is dependent on the character of the material of the pipe or conduit, and is independent of the mean hydraulic radius and the slope. It is, therefore, different from c in Kutter's modification of Chezy's formula. The other symbols of the formula are the same as in Chezy's formula; v = velocity in feet per second, r = mean hydraulic radius, and s = sine of slope.

A few problems will be given to illustrate the uses of the diagram. These will be followed by a brief discussion of the method of plotting the equation. Along the horizontal line, the grade of the pipe is given in percentages or in feet drop per 100 ft. of distance, along the vertical line the discharge for pipes flowing full is given in cubic feet per second; one set of inclined lines gives the diameter of the pipe; the other set gives the velocity in feet per second.

The diagram is based on a value of c equal to 100, and values of c for different kinds of material are given in the accompanying table. Judgment is required in the selection of the proper value of c.

Table of Values of c in Hazen-Williams Formula.

Class of pipe	c
Very best cast iron pipe	140
Good new cast iron pipe	130
Tuberculated cast iron pipe	80 to 110
New riveted steel pipe	110
Lead, brass, tin and glass pipe	120 to 140
Smooth wooden pipe	120
Brick sewers	100
Vitrified pipe	110
Smooth, clean masonry	140
Slime-coated masonry	130
Ordinary good masonry	120

It is required, for example, to find the size of a brick sewer flowing full for a discharge of 250 cu. ft. per second and a grade of 0.55 per cent. In this case c = 100. The intersection of an interpolated line of 0.55 per cent. grade with a 250 discharge line gives a diameter of about 5 ft. 8 in., and a velocity of 9.8 ft. per second.

What is the size of a vitrified pipe for a discharge of 45 cu. ft. per second flowing full at an 0.8 per cent. grade? In this case c = 110. It is evident that a smaller size than the one obtained from the diagram for 45 cu. ft. per second will suffice. Divide 45 by 110/100 and 41 will be obtained. Using 41 instead of 45 for the discharge in the diagram and a grade of 0.8 per cent., a diameter of 2.7 ft. and a velocity of 7.5 ft. per second will be obtained. The nearest commercial size of vitrified pipe would, of course, be used. The velocity 7.5 is to be multiplied by 1.1, for the real discharge is 45 and not 41. The velocity will, therefore, be 8.25 ft. per second.

A 6-ft. circular masonry conduit of ordinary good work at a grade of 0.3 per cent. is to discharge into three cast-iron pipes, two of which are to be of the same size, determine the sizes of the cast-iron pipes. For the masonry conduit c = 120, and for the cast-iron pipe c = 130. The discharge through the masonry conduit flowing full is 210 × 1.2 = 252 cu. ft. per second. The discharge through one 42-in. cast-iron pipe at a 0.4 per cent. grade is 60 × 1.3 = 78 cu. ft. per second; and through a 48-in. at the same grade, the discharge is 83 × 1.3 = 108. Therefore, two 41-in. pipes and one 48-in. will give a discharge of 264 cu. ft. per second. This combination of cast-iron pipes will more than take care of the flow from the masonry conduit.

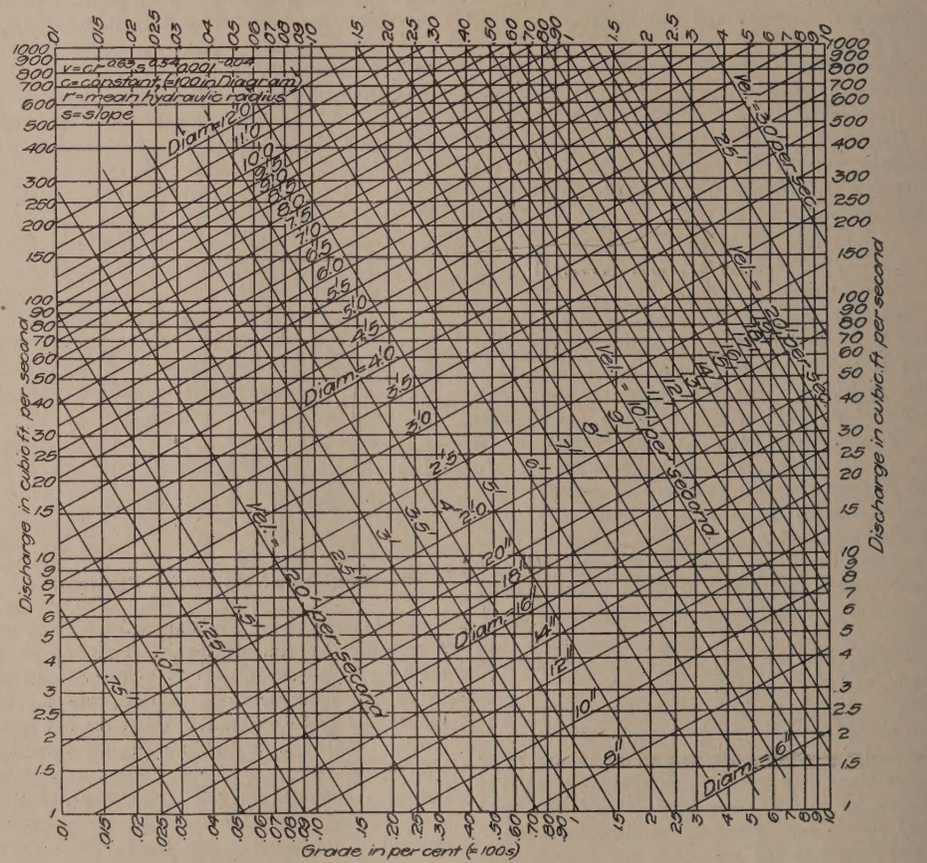
It will be noticed that the Hazen-Williams formula is exponential in form and lends itself readily to logarithmic computations. Advantage has been taken of this to employ logarithmic cross-sectioning for the diagram so that all lines will be straight and in parallel groups.

Multiplying the velocity v by the area A of the conduit in square feet, the discharge Q will be obtained in cubic feet per second. It is to be remembered, that the mean hydraulic radius r equals one-fourth of the diameter D of a circular pipe. $A = \frac{1}{4}\pi D^2$, $r = \frac{1}{4} D$, $Q = Av = \frac{1}{4}\pi \times 0.001 - ^{0.004}\, 0.25^{0.63}\, c\, D^{2.63}\, s^{0.54}$ in which D is given in feet.

The above equation reduced becomes, with c = 100, $Q = 43.23\, D^{2.63}\, s^{0.54}$. The logarithmic form of this equation $\log Q = 1.63580 \times 2.63 \log D + 0.54 \log s$.

This equation is linear in form. If, therefore, cross-section paper be ruled to a logarithmic scale in the same manner as the ordinary slide rule is divided, the relation between Q and s on this kind of ruling will be a straight line for any diameter. To obtain the straight line for D = 3 ft., substitute this value of D in the logarithmic equation, and compute two sets of values for Q and s. Plot these points on the logarithmic cross-section paper and connect them by a straight line. This line is the 3-ft. diameter line.

For instance, $\log 3 = 0.47712$ and $\log Q = 2.89063 + 0.54 \log s$.



Discharge of Round Cast-Iron Pipes.

For s = .0001; $\log s = -4$.
$\log Q = 0.73063$; $Q = 5.38$.
For s = 0.10; $\log s = -1$.
$\log Q = 2.35063$; $Q = 224$.

Plot the points (s = .0001, Q = 5.38) and (.10, 224) and connect them by a straight line to obtain the line for a diameter of 3 ft. The other lines can be obtained in the same manner. It will be noticed that all these lines should be parallel.

The velocity lines can be obtained in a similar manner from an equation giving the relation of Q, v, and s. Or the diameter lines can be used to obtain the velocity lines by help of the relation $Q = Av$. The velocity lines will also be parallel to each other.

Very truly,
Samuel D. Bleich.
New York, Nov. 16.

[Similar diagrams giving the discharge in gallons were printed in The Engineering Record of June 20, 1903.]